CE-3
FM COMMUNICATIONS MONITOR

S. E. LABS

Cushman
Electronics, Inc.

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APPLICABLE TO INSTRUMENTS WITH
SERIAL NUMBERS HIGHER THAN 1295

CE-3, FM COMMUNICATIONS MONITOR

S.E. LABS

2450 NORTH FIRST ST. • SAN JOSE, CA 95131
(408) 263-8100 TWX 910-338-0556

Litho U.S.A.

MANNEY

EFFECTIVE DATE: APRIL 1, 1977

CUSHMAN INSTRUMENT WARRANTY

All instruments manufactured by Cushman Electronics, Inc. are warranteed against defects in material and workmanship for a period of one year from the date of original shipment. Cushman will repair or replace instruments, which prove to be defective, in accordance with the following policy. This policy does not apply to repair service, parts sales, nor does it apply to instruments, or parts of the instrument, which in the opinion of Cushman, have been altered or misused.

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- During the first three months after the date of original shipment, no charge for parts, replacement PC boards, labor, or freight for instruments serviced at an authorized Cushman Service Center. Free freight applies only within the customer's country. Method of transportation shall be designated by an authorized Cushman representative or Service Center.

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- All transportation charges for instruments, parts, and replacement PC boards shall be paid by the customer during this period.

* Cathode ray tubes and batteries excluded.

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SECTION 1
GENERAL INFORMATION

Figure 1-1. CE-3 FM Communications Monitor with Model 302 Deviation Meter and Model 303 Broadband Mixer

1.1 Introduction

The Cushman CE-3 FM Communications Monitor (Figure 1-1) is designed to monitor the frequency and frequency-modulation deviation of transmitters operating in the FM-communication bands. It can also generate FM and CW signals with frequencies in those bands. The output level of the generated signal is adjustable over a calibrated range of from 0.1 to 100 microvolts, which makes it possible to determine the sensitivity of FM communications receivers.

Frequencies in the range of from 1 kHz to 40 MHz can be generated for troubleshooting purposes. In conjunction with the Cushman Model 308 Decade Frequency Divider plug-in, frequencies from 0.1 Hz to 4 kHz are available in 0.1 Hz increments, from 4 kHz to 40 kHz in increments of 1 Hz and from 40 kHz to 400 kHz in increments of 10 Hz. This permits the testing of tone-operated squelch circuits in receivers.

1.2 General Description

The CE-3 is a specialized VHF/UHF superheterodyne receiver. With it a transmitter (nearby or up to 50 miles away) can be monitored for correct carrier frequency and amount of modulation deviation. The nominal carrier frequency is "dialed-in" and the actual carrier frequency of the received signal is compared with an internally generated "standard". This standard or local-oscillator (LO) frequency automatically differs by 10 MHz from the dialed-in frequency. When the incoming signal is of sufficient amplitude, a frequency-error detector is activated and a meter shows the difference between the nominal carrier frequency and the actual carrier frequency. Discriminator circuits are also turned on which provide indication (on a Deviation Meter or Oscilloscope) of frequency deviation.

The CE-3 must operate with either a Cushman Model 301 Oscilloscope or a Model 302 Deviation Meter inserted into the left-hand plug-in cavity and a Model 303 Broadband Mixer or one of the other RF plug-ins inserted into the right-hand plug-in cavity.

The incoming signal is received at the antenna connector of whatever RF plug-in is used and a first intermediate frequency (IF) signal is produced with a frequency that is 10 MHz ± carrier-frequency error. (LO frequency = dialed-in frequency + 10 MHz*; dialed-in frequency = nominal carrier frequency; therefore: LO frequency − actual carrier frequency = 10 MHz ± carrier-frequency error.) The first IF signal is mixed with a stable 9.9-MHz signal from the Master Oscillator (MO) to produce a second IF signal with a frequency of 100 kHz ± carrier-frequency error. The error is detected and displayed on the FREQUENCY meter.

The second IF signal is also demodulated and the resultant audio-frequency signal is amplified in the Deviation Meter or in the Oscilloscope to give indication of the amount of FM deviation present in the modulation on the received carrier. The peak deviation of this modulation, as it exceeds a present level, is indicated as well.

*For some frequencies this is $f_{LO} = f_{di} - 10$ MHz.

Signal generation is accomplished by removing the automatically-introduced 10-MHz difference between dialed-in frequency and LO frequency, so that the frequency of the available signal corresponds exactly to the frequency that has been dialed-in. To accomplish the removal of this difference, the LO signal is mixed with an internally generated 10-MHz signal (not to be confused with the 10-MHz IF). This 10-MHz signal can be modulated for FM-signal generation or left unmodulated for CW signal generation. As modulation, an internally generated 1 kHz tone can be selected or, an external source of modulation (between 60 Hz and 20 kHz) may be applied.

The amplitude of FM or CW signals generated by the CE-3 is controlled by attenuators which are calibrated to give an output of between 0.1 and 100 microvolts through a 20-db fixed attenuator which is supplied with the instrument. This fixed attenuator must be used. First, because otherwise attenuator readings would be meaningless and second, because the fixed attenuator incorporates RF fuses that protect the CE-3 when it is directly connected to a transceiver which is accidentally keyed to transmit.

Examination of the front panel controls (Figure 1-1) shows that "IF FREQUENCIES" are also available for external use. This output is a signal variable throughout the audio range and throughout the range of frequencies that are usually found in the intermediate-frequency stages of commercial radio receivers (that is, a range of from 1 kHz to 40 MHz). The IF-frequency output level is not calibrated. From 0 to 4 MHz the frequencies are fundamentals, from 4 to 40 MHz the harmonic content is enhanced and the multiples of the fundamentals are available. When operated in this audio/IF-frequency-generating mode the CE-3 becomes a signal-tracing source.

The numbers that indicate the dialed-in frequency are operative in all modes of the CE-3, monitoring as well as signal-generating. The numbers are lighted for easy reading and if a frequency that is not within the operating range of the CE-3 is selected, the display will flash on and off to indicate this.

Table 1-1 lists the specifications for the CE-3 as well as the pertinent characteristics of the available plug-in accessories.

Table 1-1. Specifications

Model CE-3 FM Communications Monitor	
Frequency Coverage	20 - 80 MHz 120 - 180 MHz 450 - 512 MHz 910 - 1010 MHz (on harmonics)
Accuracy of Frequency Measurements	0.00002 % (long-term)
Frequency Meter Resolution	50 Hz*
Sensitivity	
With Broadband Mixer	Less than 10 mv at all frequencies
With Preselectors	Less than 20 microvolts at all frequencies
Input/Output Impedance	50 ohms (nominal)
Accuracy of FM Deviation Measurements**	
With Oscilloscope Plug-in	±5%
With Deviation Meter Plug-in	±4%
Signal Generation (20-512 MHz region)	
Frequency Accuracy (long-term)	0.00002 % at all frequencies
Output Level	0.1 to 100 microvolts within 2 db (into 50-ohm load)
Internal FM	1-kHz (normal) modulating frequency. Deviation continuously variable to 25 kHz. Distortion less than 2%.
External Modulating Signal	60 Hz to 20 kHz***
I. F. and Audio Signal Generation	
Frequency Ranges	1 kHz - 3.9999 MHz 4 MHz - 39.999 MHz (on harmonics)
Frequency Accuracy	0.00002 %
Output Level (1 kHz - 4 MHz)	Variable from 0 to approximately 1 volt (into 600 ohms).
Power Requirements	117 or 230 vac ±10%; 50-400 Hz; 75 watts (max)
Dimensions	12-1/4" high x 13" wide x 18"deep
Operating Temperature	+10° F to +130° F
Oven Warm Up Time	Approx. 12-15 minutes
Net Weight	
Less Plug-ins	31 lb (approx)
With Plug-ins	38 lb (approx)

*20 Hz resolution available on special request.

**Frequency modulation can be monitored on the Model 301 Oscilloscope Plug-in or the Model 302 Deviation Meter Plug-in.

***For optimum performance and minimum distortion, the product of FM deviation in kHz and the modulation frequency in kHz should not exceed 200.

Table 1-1. Specifications ' (Continued)

Model 301 Oscilloscope Plug-in			
Deviation Measurement Accuracy	±5% full scale in three ranges: ±1.5 kHz, 5.0 kHz, 15.0 kHz		
External Inputs	Vertical and Horizontal		
External Vertical Sensitivity	300 mv for full scale		
External Frequency Response (3 db)	30 kHz		
Model 302 Deviation Meter Plug-in			
Accuracy of Measurements	±4% full scale in three ranges: 0-2.5, 0-6, 0-25 kHz		
Model 303 Broadband Mixer Plug-in			
Carrier Frequency Coverage	20-80 MHz; 120-180 MHz; 450-512 MHz; 910-1010 MHz (using harmonics)		
Sensitivity	Less than 10 mv below 512 MHz		
Input Impedance	50 ohms (nominal)		
Receiver Bandwidth (3 db)			
Broad	80 kHz		
Narrow	13.5 kHz		
RF Preselector Plug-ins	Model 304	Model 305	Model 306
Frequency Coverage	25-50 MHz	145-175 MHz	450-512 MHz
Nominal Input Impedance	50 ohms	50 ohms	50 ohms
Bandwidth (3 db)			
Broad	80 kHz	80 kHz	80 kHz
Narrow	20 kHz	20 kHz	20 kHz
Sensitivity: Less than	20 microvolts	20 microvolts	20 microvolts
Model 308 Decade Frequency Divider Plug-in			
Dividing Ratios	10:1, 100:1, and 1000:1		
Input Frequency Range	10 Hz to 10 MHz		
Input Sensitivity	100 mv		
Input Impedance	300 ohms (nominal)		
Output	10v peak-to-peak square wave into 600-ohm load. Output level control provided on front panel.		
Model 309 Remote Meters			
Frequency Meter Ranges	±1.5, 5, and 15 kHz		
Deviation Meter Ranges	±2.5, 6, and 25 kHz		
Model 310 Frequency Converter Plug-in			
Carrier Frequency Coverage	20-80 MHz, 120-180 MHz, 400-420 MHz, and 450-512 MHz. Also 910-1010 MHz using harmonics.		
Sensitivity	Less than 10 mv below 512 MHz		
Input Impedance	50 ohms (nominal)		
Receiver Bandwidth (3 db)			
Broad	80 kHz		
Narrow	20 kHz		

1.3 Accessories

Three types of accessories are available for use with the CE-3: 1) units that plug into the Monitor and obtain operating power from it, 2) external instruments that plug in but have integral power supplies and 3) items furnished with the Monitor but not integral parts of it.

1.3.1 Plug-in Units

A cavity, accessible through an opening in the left-hand part of the Monitor front panel, accepts either the Model 301 Oscilloscope or the Model 302 FM Deviation Meter. One or the other of these must be used to provide FM deviation measurements. A similar cavity in the right-hand part of the front panel accepts a Model 303 Broadband Mixer, one of three RF Preselectors (Models 304, 305 and 306), a Model 308 Decade Frequency Divider, or a Model 310 Frequency Converter. The Broadband Mixer and Frequency Converter are used for measuring frequency and FM deviation of local transmitters; the preselectors are used to monitor transmitters up to 50 miles distant; and the Model 308 Decade Frequency Divider provides sub-multiples of the I.F. FREQUENCIES output of the CE-3 for testing tone-operated squelch circuits.

The Model 301 Oscilloscope permits visual examination of the exact modulation of the transmitter carrier. Unbalanced modulation, power-supply pulses, unusual clipping, and other problems are immediately apparent so that appropriate repairs can be made. The Model 301 has an automatic sync circuit, similar to that found in the most advanced laboratory instruments, to lock on and precisely display waveforms. The scope graticule is calibrated to show deviation on any one of three ranges: ±1.5, ±5, and ±15 kHz. Switches on the front panel permit use of external vertical inputs while using the internal sweep. External signals may also be connected to the horizontal input. This permits use of the Model 301 independently of the monitoring function, for routine testing, troubleshooting, displaying Lissajous patterns, etc. The Oscilloscope can also be used for receiver IF-bandwidth measurement and discriminator alignment, as described in the Model 301 manual.

The Model 302 FM Deviation Meter provides three ranges: 0 to 2.5, 0 to 6, and 0 to 25 kHz. An instantaneous-peak indicator light flashes when the absolute peak deviation of the incoming carrier exceeds an amount preset by means of the SET control. Operation and accuracy of the flasher are not affected by modulation frequency, repetition rate, or waveform. A switch permits selection and measurement of either plus (+) or minus (-) deviation peaks. A scope jack is provided for simultaneous meter indications and oscilloscope observations of deviation (a separate oscilloscope, not a Model 301, must be used).

The Model 303 Broadband Mixer operates on all frequencies covered by the CE-3. Sensitivity is less than 10 millivolts, for close-in monitoring and in-shop measurements. A crystal filter in the Broadband Mixer provides sharp selectivity when many strong RF signals are present. This filter is actuated by a front-panel toggle switch.

Three different RF-Preselector plug-ins are available for use in the CE-3. The Model 304 operates from 25 to 50 MHz, the Model 305 from 145 to 175 MHz, and the Model 306 from 450 to 512 MHz. The sensitivity of these preselectors - 20 microvolts - makes it possible to monitor base stations up to 50 miles away or to accurately identify the exact source of any interference encountered. The preselectors also have the crystal filter that permits sharp selectivity.

The Model 308 Decade Frequency Divider plug-in divides the frequency of the I.F.-FREQUENCIES signal generated by the CE-3 so that this signal can be used to test tone-selective receiver circuits and similar devices. Frequency division by 10, 100, and 1,000 can be selected by a front-panel switch. The input signal for the 308 is normally obtained from the CE-3 but, frequencies up to 10 MHz from other sources can be divided by applying them through a BNC connector on the front panel of the Model 308.

The Model 310 Frequency Converter provides coverage of an additional band - 400 to 420 MHz. The complete frequency coverage when using a Model 310 with the CE-3 is:

20 - 80 MHz
120 - 180 MHz
400 - 420 MHz
450 - 512 MHz
910 - 1010 MHz (using harmonics)

The Model 310 converts signals with frequencies in the 400-420 MHz band to signals with frequencies of from 40-60 MHz that can be monitored by the CE-3. The Model 312 Extender is designed to extend the frequency range of the CE-3 to include the 50-kHz to 20-MHz band for measurement of frequency error, FM deviation, and signal generation.

1.3.2 External Accessories

Two accessory instruments - the Model 107 Deviation Calibrator and the Model 309 Remote Meters - can be connected to the CE-3.

The Model 107 FM Deviation Calibrator provides a means of checking the deviation calibration of the Model 301 Oscilloscope and the Model 302 FM Deviation Meter on each of their FM deviation ranges. The calibrator is connected to the CE-3 by a cable to the receptacle (CH-J1) on the left side of the Monitor.

The Model 309 Remote Meters consists of an FM DEVIATION meter and a FREQUENCY meter mounted in a box which can be located at a distance of up to several hundred feet from the CE-3. The cable from the Remote Meters* plugs into the accessory receptacle (RP-J1) on the rear panel of the CE-3. A switch near the receptacle selects either internal or remote meters.

1.3.3 Auxiliary Items

Two auxiliary items are supplied with the instrument - a telescoping antenna for picking up transmitter signals and a 20-db fixed attenuator with cable for use with the CE-3 when a generated signal is being fed into a receiver. Both the attenuator and the cable are stored inside the front cover of the instrument. Installation of the antenna is described in Section 3.3, the use of the 20-db fixed attenuator in Section 5.2.5.

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*Remote Meters can only be used when the Model 302 Deviation Meter is plugged in.

SECTION 2
INSTALLATION

2.1 Unpacking and Inspection

When unpacking the Model CE-3 FM Communications Monitor inspect the packing box and the instrument for signs of possible shipping damage and see if the auxiliary items, listed in Table 2-1 and shown in Figure 2-1, are present. Verify satisfactory performance as outlined in the Operating Instructions (Section 3). If the instrument is damaged or fails to operate properly, or if any of the auxiliary items are missing, file a claim with the transportation agency or, if insured separately, with the insurance company.

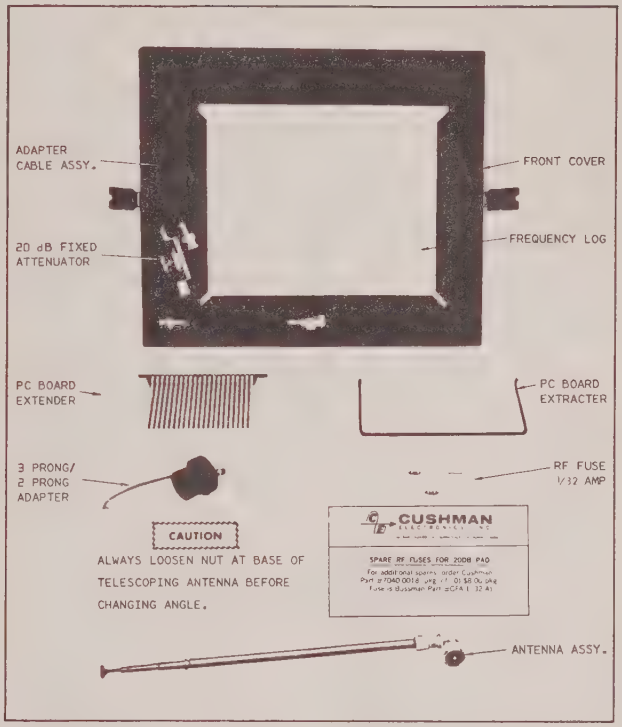

Figure 2-1. Auxiliary Items Furnished with CE-3

Table 2-1. Auxiliary Items Furnished with CE-3

ITEM	DESCRIPTION	CUSHMAN STOCK NO.	QUANTITY
1	Fuse, RF, 1/32 Amp	1955-0005	2
2	Three prong/two prong AC plug Adapter	2535-0001	1
3	Extractor, P.C. Board	3875-0036	1
4	Extender Board	7000-0085	1
5	20-db Fixed Attenuator/ Adapter Cable Assembly	7040-0016	1
6	RF Cable Assembly	7030-0014	1
7	Antenna Assembly	7040-0019	1
8	Manual, CE-3	5601-0009	1
9	Front Cover	2980-0033	1

2.2 Environmental Requirements

2.2.1 Temperature

The CE-3 is designed to operate between +10°F and +130°F (ambient). Especially in the field, these temperatures can easily be exceeded; for instance, the internal temperature of a closed automobile trunk may exceed 150°F during summer daylight hours. Avoid using the instrument outside in bright sunlight on a hot day. Do not block the cabinet ventilating louvers. Exceeding the upper or lower temperature limits for extended periods may not result in noticeable damage to the instrument, but may cause poor performance or actual malfunctioning.

2.2.2 RF Fields

Where extremely high RF radiation fields exist (such as when the CE-3 is used near a transmitter), the telescoping antenna should be pushed down to reduce pickup. Where many high-power transmitters are in use adjacent-channel interference may be experienced if the transmitters are operating within 90 kHz of each other. In such cases, the SELECTIVITY switch on the Model 303 Broadband Mixer should be placed in the SHARP position. If satisfactory measurements can still not be made, direct connection between the transmitter to be monitored and the CE-3 via an RF attenuator may be required; contact Cushman Electronics for further information. (Note: In the SHARP position the IF bandwidth is narrowed to the extent that the absolute accuracy of the deviation display on the Oscilloscope or the meter reading on the Deviation meter may be slightly degraded. The SHARP position should, therefore, be used only when absolutely necessary.)

2.3 Power Requirements

The CE-3 operates from a 117-volt or 230-volt (±10%), 50 to 400 Hz, a-c source. Power consumption is 75 watts.

2.4 Warm-up Requirements

The accuracy of CE-3 measurements depends on maintaining the master-oscillator crystal at a constant temperature. This is done by a thermostatically controlled oven which requires a 15 minute warm-up period prior to use.* Oven operation is independent of the on-off power control and it is recommended that the instrument be installed such that it can be kept connected to its power source. Thus, the CE-3 will be ready to make precise measurements within seconds after the instrument is turned on.

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*If the instrument has been stored at a temperature below +32°F, additional warm-up time may be required.

SECTION 3

OPERATING INSTRUCTIONS

3.1 General Information

The Model CE-3 can be operated in one of three modes, the first two (Frequency and Deviation Measurement, and Signal Generation) depend on the position of the function switch which is located in the center of the front panel. The third (IF Frequency), is selected by means of the first (from the left) frequency selector.

In the FREQ.-DEV. MEASURE position of the function switch, the incoming signal is applied through the ANT. connector, either from an outside antenna or from the telescoping antenna. The signal frequency is measured by "dialing-in" the assigned frequency of the transmitter with the six frequency selectors and reading the frequency error on the FREQUENCY meter. Modulation deviation is indicated simultaneously by the FM DEVIATION meter of the Model 302 Deviation Meter or on the screen of the Model 301 Oscilloscope, whichever is used. A built-in speaker makes the modulation on the incoming carrier audible.

In the SIG. GEN. position of the function switch, the desired frequency is also dialed-in with the six frequency-selector knobs. The generated signal (CW or FM) is available at the SIGNAL GEN. OUT connector. A precision attenuator provides calibrated outputs of 0 to 1, 0 to 10, 0 to 100 microvolts. When SIG. GEN./FM has been selected (instead of CW) the modulation deviation can be varied from zero to 25 kHz. An internally-generated 1-kHz modulating signal is available or, an external modulating signal can be used. The amount of deviation of the modulation on this generated signal can be read on the FM DEVIATION meter or on the Oscilloscope screen.

When audio-or IF-signal generation is desired, the first and second (from the left) frequency selectors must be used. Turning the first knob brings into view the numbers "0", "1", "4", or "5", or the letter "IF". To prepare the instrument for audio/IF-frequency signal generation, the first knob is turned until "IF" shows. Unless the second knob is turned to "0", "1", "2", or "3", the light which illuminates the six windows will flash on and off, indicating that the frequency dialed is not within the capability of the CE-3 to generate. If the first knob has been set to show "IF" and the IF-FREQUENCIES switch is in the 0-4 MHz position, output frequencies from 1 kHz to 4.000 MHz can be generated in 100 Hz increments and are selected by dialing the desired number. In the 4 - 40 MHz position of the IF FREQUENCIES switch, the decimal point appears between the third and fourth digits and frequencies up to 39.99 MHz are available in 1-kHz increments. The generated signal is available at the IF FREQUENCIES OUTPUT connector and the level is adjusted with the adjacent IF LEVEL control.

3.2 Front-Panel Controls

The front-panel controls, displays, and connectors illustrated in Figure 3-1 are listed in Table 3-1. The black knob below the FREQUENCY meter, which is used to switch from signal-measurement to signal-generation is called the "function switch" in the table and throughout the text. The six knobs in a row just below the frequency display window are used to "dial-in" a frequency; they are referred to as the "frequency selectors". Table 3-1 also describes the connectors for auxiliary equipment, located on the side and back panels. Operating controls for the plug-in units are described in the instruction books for those units.

Table 3-1. Operating Controls and Connectors

FREQUENCY meter	Indicates received-signal frequency error. This error, and whether it is above or below the dialed-in frequency, is directly indicated in kHz. The range switch below the meter permits selection of the ±1.5, ±5, or ±15 kHz meter range. The meter is also used to monitor the center frequency of the generated signal when it is modulated by the internal 1-kHz tone, but will indicate on the ±5-kHz range only.
SIGNAL LEVEL Indicator	Lights when a received signal is strong enough for reliable measurements. (Function switch in FREQ.-DEV. MEASURE position.) When the function switch is in the CAL, CW, or FM position, the indicator is lit constantly but this has no significance in terms of signal level.
Function Switch: CAL. position	In this position the FREQUENCY meter is zeroed by means of the inner (red) control knob; the FREQUENCY meter range is automatically ±1.5 kHz regardless of the position of the range switch.
FREQ.-DEV. MEASURE position	In this position the CE-3 is a receiver-monitor, and both carrier frequency and FM deviation of an incoming signal can be measured.
CW position	In this position, the CE-3 is a signal generator. The unmodulated output signal is available at SIGNAL GEN. OUT.
FM position	In this position, the CE-3 is an FM signal generator. The output signal is available at SIGNAL GEN. OUT. The frequency of the generated signal is dialed-in and indicated by the display. This indicated frequency can be varied with the inner (red) knob to ±5 kHz as indicated on the FREQUENCY meter. The modulation deviation of the generated signal can be varied with the DEV. ADJ. control as indicated on Deviation Meter or Oscilloscope.
OVEN ON Indicator	Lights as soon as the CE-3 is connected to power. After warm-up, indicator will be on approximately 5 seconds and off approximately 30 seconds.
UNLOCKED Indicator	When lit, indicates an unlocked condition in the Frequency Synthesizer.
Frequency selectors	Each frequency-selector knob associated with lighted number, permits selection of the appropriate digit in the number representing the desired frequency. The displayed number will flash on and off if a frequency is selected that is not within range of the CE-3. Normally the UNLOCKED light will also come on when this happens.
MHz/kHz/Hz Indicators	The indicators are lit according to the units in which the frequency is being displayed. For all operations described in this book, only the MHz light will be on. When a Model 308 Decade Frequency Divider is used to divide the audio/IF output signals from the CE-3, the decimal point and frequency indicator lights will indicate the output of the Decade Frequency Divider.

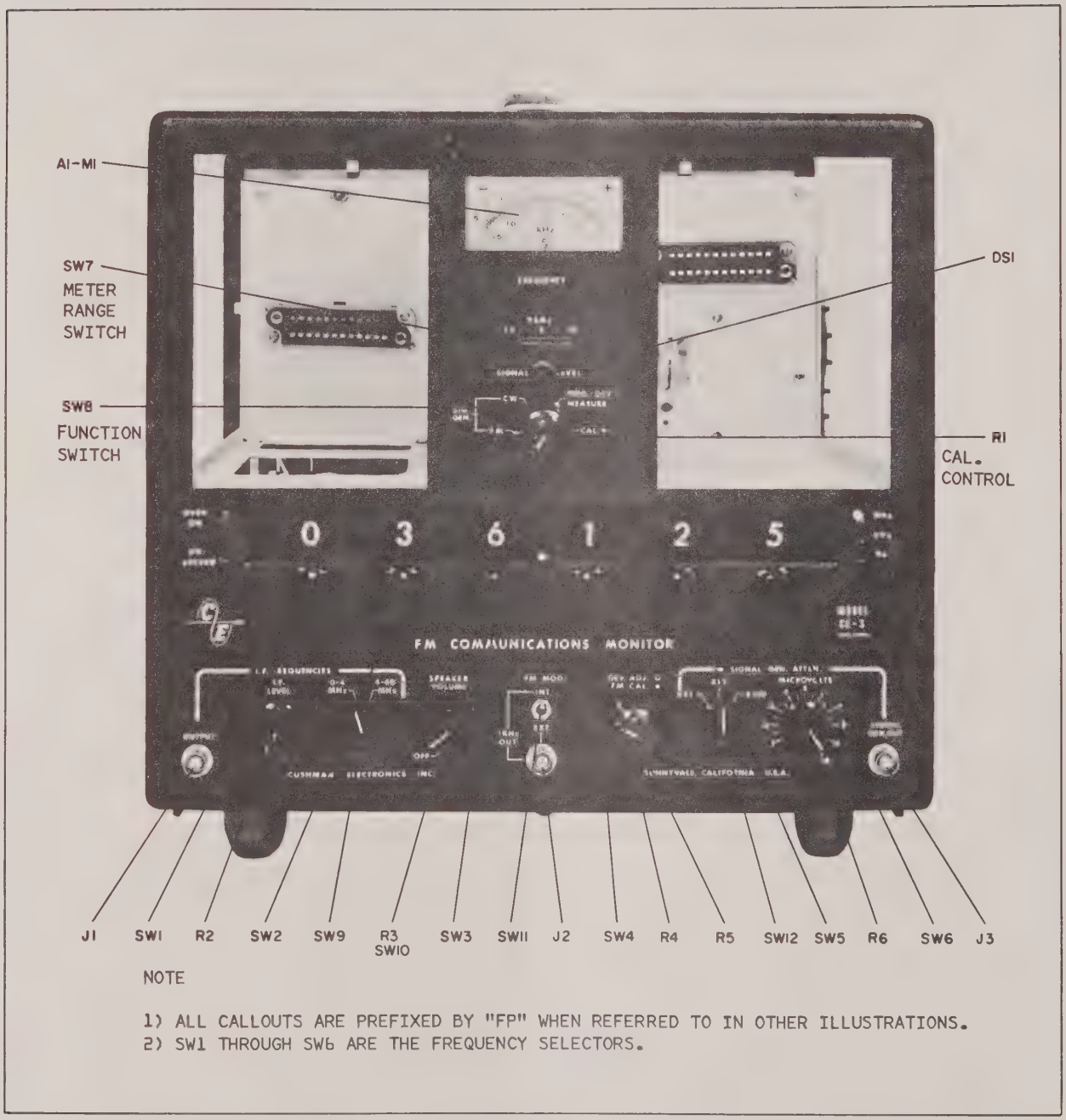
Table 3-1. Operating Controls and Connectors (Continued)

I. F. FREQUENCIES Controls and Connector	Generation of audio/IF signals is selected by turning the first (from the left) frequency selector so that the letters "IF" are displayed. Then, with the I. F. FREQUENCIES range switch set to 0-4 MHz, frequencies between 1 kHz and 4 MHz can be dialed-in with the other frequency selectors. When the I. F. FREQUENCIES range switch is in the 4-40 MHz position, harmonic frequencies between 4 and 40 MHz are strong enough to be used. For both ranges, the signal is available at the I. F. FREQUENCIES OUTPUT connector; its level can be adjusted with the I. F. LEVEL control, but this level is not calibrated.
SPEAKER VOLUME Control/OFF Switch	In the OFF position, only the crystal oven is supplied with a-c power. When not in the OFF position, a-c power is supplied to the instrument and the associated potentiometer permits adjustment of the audio output level.
FM MOD. Switch and Connector	When the function switch is in the FM position, the FM MOD. switch permits selection of an internal or an external source of modulation. In the EXT. position of the switch the BNC connector is connected to the 10-MHz modulator. In the INT. position, an internally generated 1-kHz signal is used. This same 1-kHz signal is then also available at the above-mentioned BNC connector for external use.
DEV. ADJ. and FM CAL. Controls	These two controls are used when the function switch is in the FM position. The DEV. ADJ. control sets the desired amount of deviation of the FM signal generator output. The deviation is shown on the Deviation Meter or Oscilloscope. The DEV. ADJ. control also adjusts the level of the internally generated 1-kHz signal at the 1 kHz OUT connector. The FM CAL. control is used to adjust the center frequency of the generated FM signal, as indicated on the FREQUENCY meter. The range is automatically ±5 kHz when the function switch is in the FM position.
SIGNAL GEN. ATTEN. Controls and Connector	A vernier control (0.1 to 1.0 microvolt) and a multiplier (X1, X10, and X100) provide control of the RF output levels at the output of the 20-db fixed attenuator, which must be connected to the SIGNAL GEN. OUT connector.
Remote Meters Connector (rear panel)	Permits use of a Cushman Model 309 Remote Meters if the slide switch associated with this connector is in the EXT. position.

NOTE

If the CE-3 Frequency Meter or the Deviation Meter plug-in seem inoperative under otherwise normal measuring conditions, the INT.-EXT. switch on the rear panel should be checked. Model 109 Remote Meters, designed as an accessory for the Model CE-2B can also be used by changing one connector on the interconnecting cable. The external deviation meter in both the Model 309 and Model 109 will function only when the Model 302 FM Deviation Meter Plug-in is being used with the CE-3. (The Remote Meters cannot be used if the Model 301 Oscilloscope is in use.)

Auxiliary equipment and connector (left side of cabinet provides the operating voltages and signals for the Cushman Model 107 FM Deviation Calibrator or Model 108 Decade Frequency Divider. These were standard accessories for the earlier Cushman FM Communication Monitors Models CE-2 and CE-2B; they can also be used with the Model CE-3.



NOTE

1) ALL CALLOUTS ARE PREFIXED BY "FP" WHEN REFERRED TO IN OTHER ILLUSTRATIONS.
2) SW1 THROUGH SW6 ARE THE FREQUENCY SELECTORS.

Figure 3-1. Front-Panel Controls and Connectors

3.3 Turn-on and Warm-up

a. Plug the power cord into an ac power outlet (117 volts ±10%, 50 to 400 Hz) and turn on the power by means of the on/off switch on the SPEAKER VOLUME control.

b. Allow the CE-3 to warm up for approximately 14 minutes.*

*If the instrument has been stored at a temperature below +32° F, additional warm-up time may be required.

3.4 Frequency and Deviation Measurement

It is assumed that the CE-3 is equipped with a Model 303 Broadband Mixer and either the Model 301 Oscilloscope or the Model 302 Deviation Meter. For measurement of frequency and deviation with one of the RF Preselectors instead of the Model 303 the same procedure is followed except that the Preselector frequency dial must be set to the frequency dialed-in with the frequency selectors.

a. Connect an external antenna or the telescoping antenna supplied with the instrument to the ANT. connector. If the telescoping antenna is used, extend it to its full length for low band measurements, to approximately 18 inches for high band measurements, and use minimum length for UHF measurements.

b. Turn the function switch to CAL.

c. Adjust the inner red knob (part of the function switch) for a zero (mid-scale) reading on the FREQUENCY meter.

d. If the Model 301 Oscilloscope is being used, set the toggle switches for horizontal and vertical inputs to the INT. position and adjust the VERT. POS. control so that the trace is on the zero reference line while the deviation range switch is in the ±1.5 position. Adjust the scope INTENSITY, FOCUS, and ASTIGMATISM controls for a sharp trace on the screen.

e. Change the function switch to the FREQ.-DEV. MEASURE position.

f. Dial-in the transmitter's assigned frequency with the six frequency selectors.

g. Key the transmitter. The SIGNAL LEVEL light should come on. If it does not, move the CE-3 closer to the transmitter until the received signal is strong enough to turn on the light. Normally, measurements can be made easily when the CE-3 is between 25 and 50 feet from the radiating antenna.*

h. Read the difference between transmitter's assigned frequency and actual, transmitted carrier frequency on the Frequency Meter. Select the appropriate, lowest meter range (with the lever switch just below the meter) for greatest accuracy.

i. Modulate the transmitter and read the FM deviation on the FM DEVIATION meter or the Oscilloscope. Select the appropriate meter or scope range with the range switch (kHz knob on Deviation Meter, kHz lever switch on Oscilloscope). On the oscilloscope screen, peaks appear above and below the horizontal centerline of the display; the Deviation Meter indicates either positive or negative peaks, depending on the setting of the FM DEV PEAKS switch. If the DEVIATION PEAKS indicator level on the Deviation Meter plug-in has been set (see Section 3.8), all modulation peaks that exceed this level will cause the indicator to light. The accuracy of the Deviation Meter or Oscilloscope readings can be verified by means of the Cushman Model 107 FM Deviation Calibrator.

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*When a plug-in Preselector is being used, measurements can be made at distances up to 50 miles from the transmitter assuming the use of an adequate external antenna.

3.5 "Out of Band" Frequencies

In conjunction with a Model 303 Broadband Mixer, the CE-3 can be used to measure the frequency and deviation of signals between 80 and 120 MHz, 270 and 320 MHz, and between 910 and 1010 MHz. These frequencies are second harmonics of frequencies normally covered by the CE-3: 20 - 80 MHz, 120 - 180 MHz, and 450 to 512 MHz. Because second-harmonics are weaker than their fundamentals, the CE-3 must be near the source.

The procedure for determining the correct frequency to dial-in is as follows:

a. Subtract 10 MHz from the desired frequency.

b. Divide the remainder by 2.

c. Dial-in the resulting quotient plus 10 MHz.

For example, assume that the signal of a transmitter with an assigned frequency of 960 MHz must be measured. The first step is to subtract 10 MHz which would give 950. Then, divide by 2 which would give 475 MHz. Finally, , adding 10, the frequency to be dialed in would be 485 MHz. With this setting, the CE-3 will respond to a 960 MHz signal and the frequency error and FM deviation indicated will be those of the transmitter that is being monitored. For a desired frequency of 90 MHz, the dial-in frequency would be 90-10=80: 80 ÷ 2 40; 40 + 10=50 MHz.

To generate out-of-band frequencies this same procedure is followed to calculate the frequency that must be dialed-in. For instance, to generate 960 MHz (see above) 485 is dialed-in. Because the desired frequency is a second harmonic, the output signal level will not be as indicated on the SIGNAL GEN. ATTEN controls.

3.6 CW-Signal Generation

a. Set the six frequency selectors to the desired frequency.

b. Place the function switch in the CW position.

c. Connect the coaxial cable and the 20-db fixed attenuator (stored inside the front cover) between the panel connector marked SIGNAL GEN. OUT, and the transceiver to be tested.

d. Adjust the output level with the attenuator controls.

CAUTION

Whenever a direct connection is made between the CE-3 and a transceiver, keying the latter to transmit will damage the 20-db fixed attenuator and possibly, the CE-3.

3.7 FM-Signal Generation

a. Dial the desired frequency with the six frequency selectors.

b. Place the function switch in the FM position.

c. Set the FM MOD. switch to INT. or EXT. as desired.

In the INT. position the modulating frequency will be 1 kHz; external modulation signals can be applied through the EXT./ 1-kHz OUT connector when the switch is in the EXT. position. The 1-kHz is available

at the EXT/1-kHz OUT connector for external use when the FM MOD. switch is in the INT. position.

NOTE

The FREQUENCY meter now shows the modulation center frequency, and the FM DEVIATION meter or Oscilloscope now indicates the amount of deviation of this modulation.

d. Use the DEV. ADJ. control to set the amount of deviation, and use the FM CAL control to fine-tune the center frequency until the FREQUENCY meter reads zero.

NOTE

The FM CAL. control varies the center frequency of the FM signal and permits testing the alignment and maximum sensitivity of receivers. The deviation range of the plug-in Deviation Meter or Oscilloscope can be selected by means of a switch on the front panel of each plug-in; but the FREQUENCY meter is automatically on the ±5-kHz range when the function switch is in the FM position, and it cannot be changed by the meter range switch.

e. Steps c and d of Section 3.6 and the caution note in that section also apply to FM-signal-generation.

3.8 Deviation Peaks Indicator Adjustment

The DEVIATION-PEAKS indicator on the Deviation Meter plug-in can be made to flash when deviation peaks exceed a preset limit. To establish this limit the SET control is adjusted and the internal FM signal generator is used.

a. Follow the procedure outlined in steps a through e of Section 3.7. With the FM MOD. switch in the INT. position, adjust the DEV. ADJ. control for the desired FM deviation.

b. Turn the SET control to its maximum counterclockwise position. The DEVIATION PEAKS indicator should light.

c. Slowly rotate the SET control clockwise until the light just goes out. The trigger level is now set at the deviation level generated by the CE-3 at that moment.

d. Rotate the function switch to the FREQ.-DEV. MEASURE position, and use the CE-3 for measuring frequency and deviation. The calibration of the DEVIATION PEAKS light is not affected by changing the frequency selector to a different channel. Positive or negative-going peaks are indicated depending on the setting of the FM DEV. PEAKS switch.

3.9 Audio- and IF-Signal Generation

a. Rotate the first frequency selector (from the left) to the extreme clockwise position so that "IF" shows in the display window. If the frequency display window light flashes on and off, this indicates a dialed-in frequency which the CE-3 cannot generate. Only if the second frequency selector is turned to "0", "1", "2", or "3", will the light remain steady.

b. Set the IF FREQUENCIES range switch to either 0-4 or 4-40 MHz, as desired.

c. Dial-in the desired IF-or audio frequency. (Audio frequencies below 1 kHz can be generated; however, the output frequencies will have slight amounts of residual FM.)

d. The generated signal is available at the front-panel I. F. FREQUENCIES OUTPUT connector. Its level can be varied with the I. F. LEVEL control.

e. The basic output frequency range is always 0-4 MHz, variable in 100-Hz steps. When the switch is placed in the 4-40 MHz position, the harmonics of the fundamental frequencies can be used.

3.10 Generation of Frequencies Below 100 Hz

Frequencies below 100 Hz for reed-relay selectors and other uses can be generated by using a Cushman Model 308 Decade Frequency Divider in conjunction with the CE-3.

3.11 Receiver-Band-Width Check

One of the ways in which the CE-3 can be used to troubleshoot other equipment is to use its signal-generating function to determine the bandpass of a receiver.

a. Place the CE-3 in the FM signal-generating mode (function switch to FM).

b. Dial-in a frequency within the range of the receiver (preferably mid-way in that range).

c. Vary the setting of the FM CAL. knob (red knob concentric with the DEV. ADJ. control) and observe that the FREQUENCY meter deflects toward the plus (+) or the minus (-) side when this knob is turned.

d. Turn the FM CAL. knob to the position which causes the FREQUENCY meter to read "0".

e. Observe the signal strength meter for a sudden drop in the reading as the FM CAL. knob is turned. Adjust this knob to a position where the receiver meter just begins to dip. Note the reading of the FREQUENCY meter on the CE-3.

f. Repeat step e while turning the FM CAL. knob in the opposite direction. Note the reading of the FREQUENCY meter on the CE-3.

g. If the FREQUENCY meter deflects less in one direction than in the other, or if these deflections are not great enough; align the receiver until the FREQUENCY meter deflects equally far, and far enough in both directions. (Note: In the FM mode only the ±5 kHz meter range is available).

SERIAL NO. 784 AND LATER

As shown in figure at left db calibrations were added to the attenuator controls. At X100 (0 db) and 1.0 (0), using 20-db fixed attenuator, the signal level is 100 microseconds. At X10 (-20 db) and 0.5 (-6) attenuation is 20 db; for a 5-microvolts signal. At X100 (0 db) and .5 (-6) attenuation is 6 db for a 50-microvolt signal, etc. (Escutcheon plate pictured is free upon request from Cushman Electronics, Customer Service Dept.)

SECTION 4
CIRCUIT DESCRIPTION

4.1 General Information

The Model CE-3 is essentially a VHF/UHF Superheterodyne Receiver with alternate "frontends". The front-end may be a Model 303 Broadband Mixer or one of the three available Pre-selectors (Models 304, 305, 306). Although these plug-in units have different characteristics, they all provide IF- and control signals that are used in the CE-3 to measure carrier-frequency and FM deviation.

NOTE

In this section reference is made to two groups of figures: simplified representations interspersed with text and schematics grouped together in Section 6. Each of the latter category is associated with a corresponding parts list and a photograph of the sub-assembly (Parts Pictorial).

The principal function of the CE-3 is to measure the frequency of an incoming signal and determine whether the transmitter of that signal is operating on its assigned frequency. The number that is dialed-in on the CE-3 represents the frequency the signal should have, its assigned frequency.

To determine if the transmitter is "on frequency", the frequency of its signal must be compared with some accurately derived "standard". The most convenient and accurate way to make such a comparison is to produce "standard" frequencies that are always exactly 10 MHz away from what the incoming-signal frequencies should be. Thus, the difference between the incoming-signal frequency and the "standard" frequency will always be 10 MHz if the former is correct.

If the frequency assigned to the transmitter to be monitored is 123.456 MHz, the number 123.456 must be dialed-in. The "standard" frequency with which the incoming signal is compared is then 133.456 MHz. In this example the "standard" is 10 MHz higher than the dialed-in frequency; for some other frequencies the "standard" is 10 MHz lower. Nevertheless, the difference is always 10 MHz if the incoming signal is "on frequency".

If each separate "standard" frequency for each frequency in the range over which the CE-3 can be used had to be generated, a very wide band oscillator would be required. This oscillator would have to be variable over the entire CE-3 range while, in addition, maintaining the extreme accuracy that makes the CE-3 measurements so valuable.

Instead of such an oscillator a Frequency Synthesizer is used in the CE-3. For the purpose of this description, frequency synthesis means that signals generated in a limited range of relatively low frequencies (all referenced to one crystal oscillator) are modified to attain the wider range of much higher frequencies required.

The signal to be monitored is applied to the ANT/RF IN connector (Figure 4-1) of the particular frontend that is being used. In the frontend (Broadband Mixer or Pre-selector) the incoming RF signal is mixed with a Local Oscillator (LO) signal that comes from the Frequency Synthesizer. The LO frequency is determined by the setting of the six frequency selectors on the CE-3 front panel and is automatically 10 MHz displaced from the frequency value that was dialed-in and that is displayed by the illuminated numbers associated with the frequency selectors.

If the incoming signal is exactly the same as the selected frequency, the frontend

delivers an IF signal to the CE-3 that is exactly 10 MHz. If the incoming-signal frequency differs from the selected frequency, the IF signal will have a frequency of 10 MHz plus or minus the amount by which the incoming signal is "off frequency".

The IF signal is heterodyned in a second mixer (p/o the CE-3) with a 9.9 MHz output from the Frequency synthesizer to produce a signal with a frequency of 100 kHz plus or minus the amount by which the incoming signal is "off frequency". This signal is applied to a frequency-error detector which, when activated by a squelch voltage from the frontend (proportional to signal strength), detects the plus-or-minus amount of frequency error. This squelch voltage also lights the SIGNAL LEVEL indicator when the signal level is above a preset level. The frequency-error detector (a discriminator circuit), is adjusted to cause a Zero indication of the FREQUENCY meter when the input to the discriminator is 100 kHz plus or minus Zero. If there is a frequency error, the FREQUENCY meter will indicate the amount by which the incoming signal is "off frequency" and whether it is a plus or a minus error.

If the monitored signal is frequency modulated, this modulation is present in the output of the frequency-error detector. The signal is demodulated and a signal representing the modulation is fed to the Deviation Meter or the Oscilloscope, whichever is being used. If the Model 302 Deviation Meter is used, the peak deviation of the signal will be indicated on its FM DEVIATION meter while, at the same time, being available at its SCOPE connector for display on the screen of a separate Oscilloscope. If the Model 301 Oscilloscope plug-in is used, peak-to-peak frequency deviation will be displayed on the screen. In addition, the CE-3 has a built-in speaker and SPEAKER VOLUME control which permit making the signal audible.

The CE-3 can also be used as a CW- or FM-signal generator. The signal output is, with some modification the same signal that is used as "standard" when the CE-3 is used in the measurement mode. Since the "standard" is always 10 MHz away from the frequency indicated by the illuminated figures on the front panel, this 10 MHz must be added or subtracted to obtain a generator output with the dialed-in frequency. This addition or subtraction, depending on whether the "standard" is below or above the desired frequency, is performed in the Signal Generator Mixer.

When an FM signal is desired, an internally-generated, 1-kHz tone is used to frequency modulate the 10-MHz signal that is mixed with (added to or subtracted from) the "standard". An external audio signal may be applied through the EXT. MOD. IN/1 kHz OUT connector and be similarly impressed on the 10-MHz signal. When the FM MOD. switch is in the INT. position the 1-kHz modulating signal is availabe for external use at this same connector.

The deviation of both the internally-generated and externally-applied modulation signals can be varied by means of the DEV. ADJ. control.

When the CE-3 is used as a FM-signal generator, the Model 302 Deviation Meter or the Model 301 Oscilloscope indicates the amount of deviation of the modulation impressed on the generated signal. Both the CW and the FM signals generated by the CE-3 are passed through a precision attenuator which is calibrated such that the output level is indicated by the position of the SIGNAL GEN. ATTEN. controls on the front panel. The output-level reading is ONLY correct, however, if the generated signal is taken off through the 20-db fixed attenuator supplied with the CE-3.

In addition to the RF-frequency signals and the 1-kHz tone, the CE-3 also provides audio- and IF- frequency signals. These

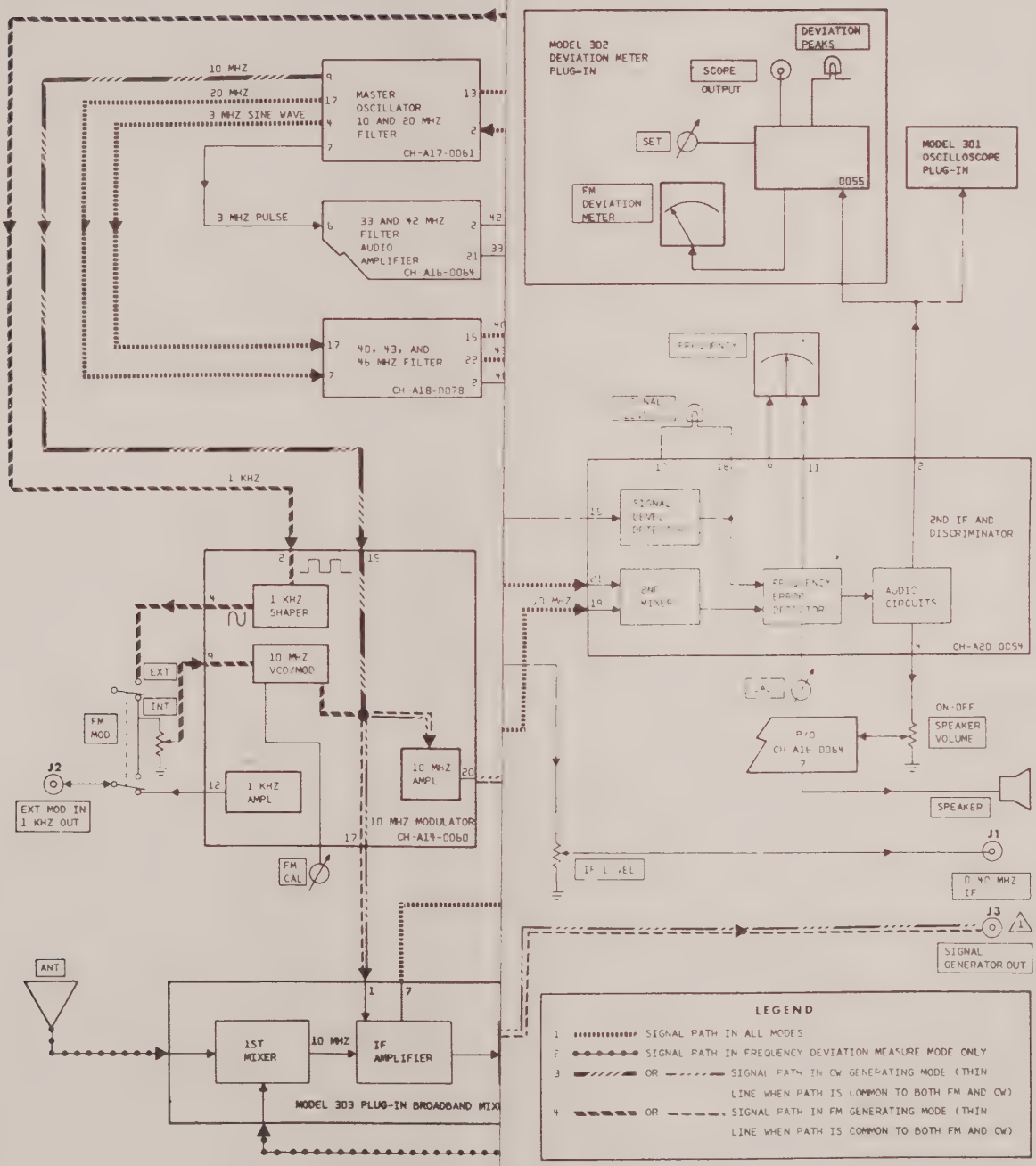


Figure 4-1. CE-3, Overall Block Diagram

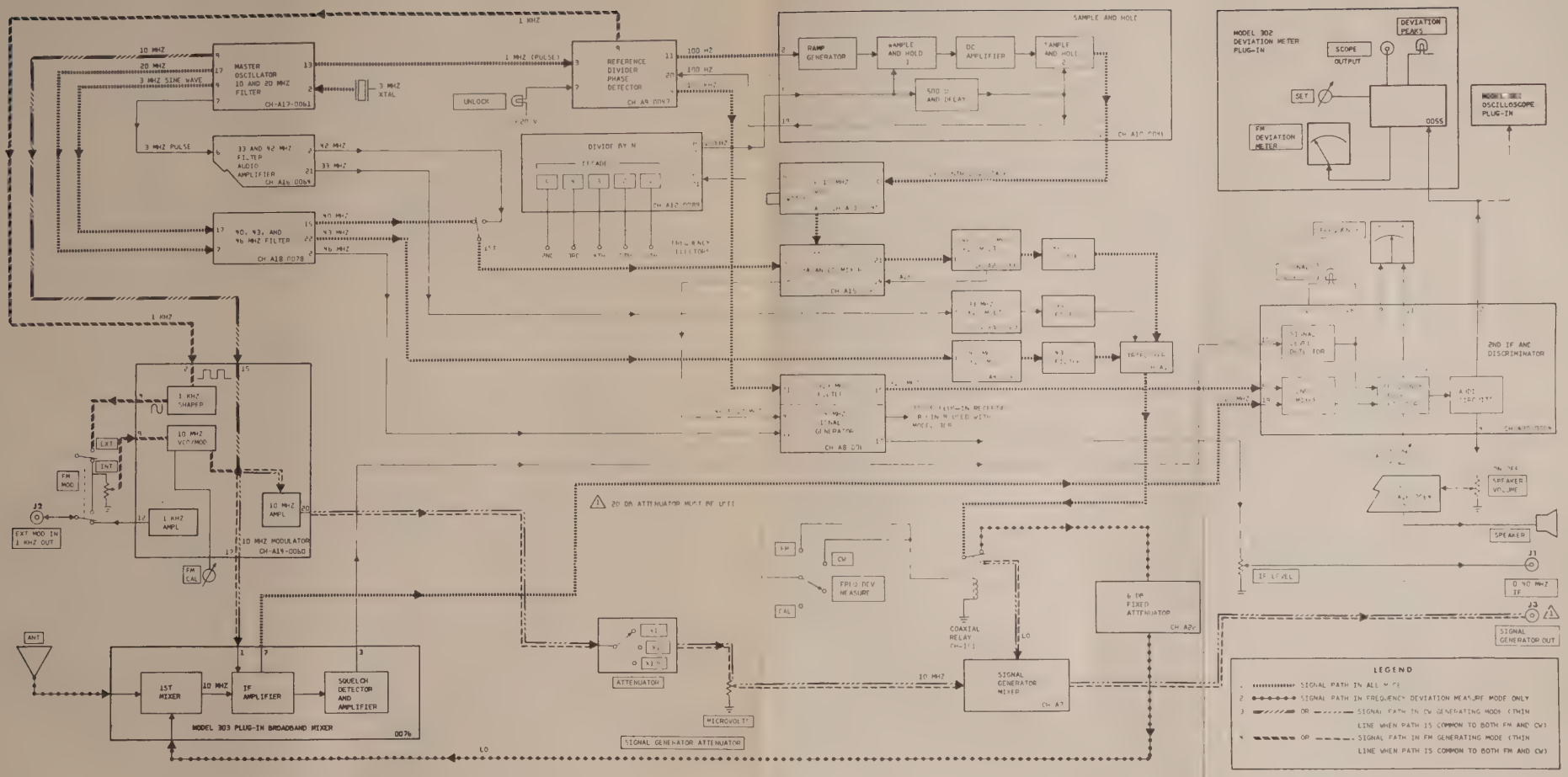


Figure 4-1. CE-3, Overall Block Diagram

For instance, if the number "123.456" were dialed-in, the VCO would oscillate at 6.3456 MHz; adding 40 MHz would give 46.3456 MHz; multiplying by ten would bring the frequency to 463.456 MHz; and subtracting 330 MHz would give a "standard" of 133.456 MHz, 10 MHz higher than the 123.456 MHz that was dialed in.

When a frequency is dialed-in, the VCO is adjusted to within 100 kHz of the frequency it must produce by the settings of the first, second, and third frequency selectors. For the values used in the example (123.456/6.3456) this is between 6.3000 and 6.4000 MHz. The setting of all six frequency selectors program the ÷N Counter to the exact VCO frequency associated with this setting. At first the frequency at which the VCO oscillates is not exact to the last three digits and it "hunts" for a few cycles. When the frequency is exactly right, but not until then, the ÷N counter produces a 100 Hz output signal.

Figure 4-2 is a simplified block diagram of the frequency synthesizer. The loop is shown in the phase-locked condition and therefore the ÷N output is represented as being 100 Hz.

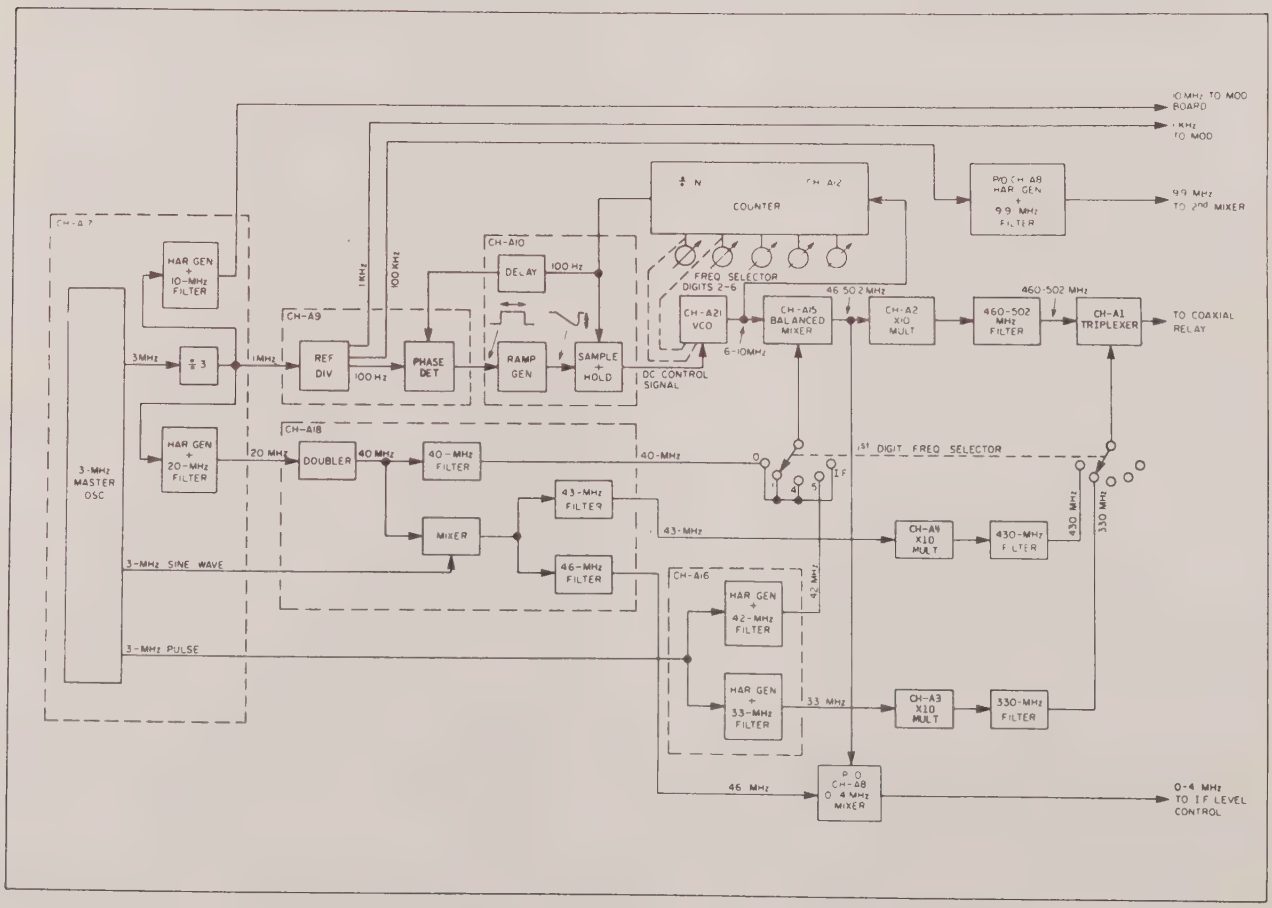


Figure 4-2. Frequency Synthesizer, Simplified Block Diagram

When the VCO produces a signal with a frequency of 6.3456 MHz or, 6,345,600 Hz, the ÷N counter must accept 6,345,600 pulses per second. The counter divides this input by "N" which stands for the variable quantity for which it can be programmed. In the example N = 63,456 and 6,345,600 ÷ 63,456 = 100. Thus, except for the very short time during which the VCO "hunts" for the correct frequency, the ÷N counter output is always 100 pulses per second or 100 Hz.

The 100-Hz output of the ÷N counter is phase-compared with a stable 100-Hz signal from the MO. When the signals have the proper phase relationship, this condition is represented by a pulse of a certain duration (Phase Detector). Each pulse is transformed into a ramp voltage (Ramp Generator) with a duration that is proportional to the width of the pulse. Each ramp is sampled and a capacitor is charged to the amplitude of the sample. The capacitor retains a certain portion of its charge and a second sampling takes place. A second capacitor charges to a potential corresponding to the charge that is retained by the first capacitor and the second capacitor retains this exact charge for as long as the two 100-Hz signals have the proper phase relationship. The potential to which the second capacitor charges is used as a control voltage on a Varicap in the VCO circuit. Since it is a Varicap characteristic to change capacitance according to a control voltage, it acts as a fine-tuning device to adjust the VCO to precisely the frequencies required.

The VCO output is combined with either a 40 or a 42 MHz signal (Balanced Mixer) and multiplied by ten (x 10 Multiplier). The signal is then filtered (460 to 502 MHz Filter) and finally a fixed frequency, 330 MHz, 430 MHz or Zero, is subtracted (heterodyned).

The output of the Triplexer (which consists of the multiplied and filtered Balanced Mixer output and the fixed frequency) is passed through one set of contacts of a coaxial relay and a 6-db fixed attenuator to the mixer in the front end (1st Mixer, see Figure 4-1). In this mixer it is used as the "local oscillator input" and heterodyned with the incoming RF signal.

When the CE-3 is used as a signal generator, (FM or CW) the other set of contacts of the coaxial relay is closed and the Triplexer output is fed directly to the Signal Generator Mixer where, in addition to mixing the Balanced Mixer output with the fixed frequency, 10 MHz is added or subtracted to make the SIGNAL GEN. OUT signal coincide with the dialed-in frequency.

When the CE-3 is used to generate signals with audio- or IF frequencies, signal processing is as has been described for the FREQ. DEV.-MEASURE mode, but only up to the point where the signal has passed through the Balanced Mixer. After this, the signal is not fed to the x 10 Multiplier but to a 0-to-4 MHz Mixer. Table 4-2 shows the frequency relationships in the Frequency Synthesizer that prevail in this case. A comparison between Tables 4-1 and 4-2 reveals that the fixed-freq. input to bal. mixer column has been ommitted. This was done because the fixed

Table 4-2. Frequency Relationships — Audio and IF Signal Generation

Frequency Selector Setting	VCO Freq. (MHz)	Balanced Mixer Output (MHz)	0-4 MHz Mixer Output (MHz)
0.0000 - 0.9999	6.0000 - 6.9999	46.0000 - 46.9999	0.0000 - 0.9999
1.0000 - 1.9999	7.0000 - 7.9999	47.0000 - 47.9999	1.0000 - 1.9999
2.0000 - 2.9999	8.0000 - 8.9999	48.0000 - 48.9999	2.0000 - 2.9999
3.0000 - 3.9999	9.0000 - 9.9999	49.0000 - 49.9999	3.0000 - 3.9999

Notes: 1. 1st-digit frequency selector knob is on "I.F."

2. Fixed-frequency input to Balanced Mixer is always 40 MHz for I.F. signal generation.

frequency that is added when audio- and IF-frequency signals are generated, is always 40 MHz. And, in the 0-to-4 MHz range, a fixed frequency of 46 MHz is always substracted from the sum of the VCO frequency and the fixed frequency (40 MHz). This subtraction results in signals with frequencies that vary between 1 kHz and 4 MHz* according to the setting of the frequency selectors. When the IF FREQUENCIES selector is moved to the 4-40 MHz position the harmonics of signals from 0.4 MHz to 4 MHz are enhanced and can be used.

Figure 4-2 shows that the Frequency Synthesizer provides a 10-MHz and a 9.9 - MHz output. The 10-MHz signal is used for calibration and CW generation; the 9.9-MHz signal is heterodyned with the output of the frontend to provide an input to the frequency-error detector.

4.2.1 Master Oscillator, Divider, and Filters (CH-A17)

Printed circuit board 0061 on which these circuits are located provides the following outputs:

a. A 1-MHz signal for the Reference Divider

b. A 3-MHz sine-wave for the 43-MHz/ 46-MHz Mixer

c. A 3-MHz pulsed output for the 33-MHz and 42-MHz Harmonic Generators

d. A 10-MHz signal for discriminator calibration and CW generation

e. A 20-MHz signal for the 40 MHz Doubler.

As shown in the schematic, Figure 6-1, transistor Q1 is part of a modified Pierce oscillator circuit. The 3-MHz crystal is electrically in the base circuit of Q1 but physically in a separate Crystal Oven, CH-A6, Figure 6-1. The sine-wave output of the oscillator is fed through untuned isolation amplifier Q2 to IC2 and also to board-pin 4. Integrated Circuit, IC2, is a pulse shaper which changes the 3-MHz sine wave to a square wave. This square-wave output is fed to the 33 and 43-MHz Filter via board-pin 7 and also to IC1 which is connected as a counter. Integrated circuit, IC1, produces one output pulse for every three input pulses, or a 1-MHz signal. Pulse-shaper, IC3, accepts the 1-MHz signal and provides inputs for the 10-MHz and 20-MHz Filters on the board itself and via board-pin 13, for the Reference Divider.

4.2.2 Reference Divider and Phase Detector (CH-A9)

Printed circuit board 0047 carries the circuits of the Reference Divider and the Phase Detector.

The Reference Divider circuit is shown in the upper part of Figure 6-2. The 1-MHz signal from the MO is processed by decade counters IC1, IC5, IC7, and IC8, and buffer amplifiers IC3, IC9 and IC10, to produce a 100-kHz, a 1-kHz, and a 100-Hz output. The first two outputs are availabe at board-pins 4 and 9; the third output is fed to IC2 of the Phase Detector which is shown in the lower part of the schematic (Figure 6-2).

Integrated circuit IC2 contains a flip-flop which is "set" through terminal 6 and "reset" through terminal 5. The 100 Hz signal from the Reference Divider turns this flip-flop on and the 100 Hz signal from the ÷N Counter, which comes via the delay circuit on the sample-and-hold board and board-pin 20, turns the flip-flop off. The width of the flip-flop output pulse (TP3, Figure 6-2) is constant and its amplitude is correct only when the two input signals have the correct phase relationship (this is referred to as being phase-locked).

Under normal operating conditions the signal from the Reference Divider is always 100 kHz. The frequency of the signal from the ÷N Counter may, at times, vary. If there is such a variation this will be manifested by a change in duration and height of the phase-detector output pulse. A control voltage proportional to this change is later used to vary the capacitance of the Varicap in the VCO circuit to tune it to the frequency it is supposed to produce.

*Frequencies between 0 and 1 kHz are present but not recommended for use.

Part of IC4 is used as a buffer stage through which the phase-detector output is passed before it is fed, via board-pin 11, through the sample-and-hold circuit to the VCO. The other part of IC4 is a frequency discriminator which operates in conjunction with the phase detector (IC2). An output of this portion of IC4 triggers the one-shot multivibrator, (IC6) which gates a bias voltage to the Lamp Driver, switching transistor Q1.

When the phase relationship between the input signals does not change, and therefore, when the frequency is constant, the output of IC6 is low and Q1 is off. When the opposite condition prevails, that is, when the loop is "unlocked", the output of IC6 is high and Q1 conducts. This lights the UNLOCKED indicator by providing its lamp with a ground return.

4.2.3 Voltage-Controlled Oscillator (CH-A21)

The circuits on printed circuit board, 0045, produce a signal with a frequency in the range of from 6 to 10 MHz. Which frequency is produced, depends on the setting on the front-panel frequency-selector settings.

As shown in Figure 6-3, the oscillator circuit includes transistor Q1 and four separate tank circuits. The resonant frequency of each tank can be varied by applying one of ten capacitances in parallel with it. The oscillator is then fine-tuned by a Varicap which is always in the circuit but the capacitance of which is varied by a control voltage developed in the Phase-Detector and the Sample-and-Hold circuits.

The appropriate tank circuit is selected with the first and second frequency selectors. Table 4-3 shows in which combinations of selector settings a ground potential is applied to dual diodes, CR1A/B through CR5A/B.

Also indicated in the Figure 6-3 is the mechanical coupling (shaft) by which the third frequency selector is coupled to a rotary switch in the VCO assembly. Thus, depending on the setting of the third frequency selector the correct capacitance is switched in parallel with the selected tank circuits.

Table 4-3. VCO Tank Circuits Enabled by Combinations of First- and Second-Frequency-Selector Settings

FIRST \ SECOND	0	1	2	3	4	5	6	7	8	9
0 +1			I	II	I	II	III	IV		
4						I	II	I	II	III
5	II	III								
IF	I	II	III	IV						

I represents 6 to 7 MHz Tank Circuits
II represents 7 to 8 MHz Tank Circuits
III represents 8 to 9 MHz Tank Circuits
IV represents 9 to 10 MHz Tank Circuits

Finally, the Varicap, CR2, under influence of the control voltage, the amplitude of which depends on a phase and frequency comparison between the VCO frequency (counted by the ÷N Counter) and a stable signal from the MO, provides the additional capacitance required to fine-tune the tank circuit.

Returning to the example used previously: a dialed-in frequency of 123.456 MHz is associated with a VCO frequency of 6.3456 MHz. Therefore, when the first frequency selector is placed in the "1" position and the second frequency selector in the "2" position, the 6- to 7-MHz tank circuit is selected. Because of the position of the third frequency selector ("3"), the C22/C23 combination is switched in parallel with the tank circuit. Finally, the ÷N Counter is programmed by the last three frequency selectors, so that it will only produce the correct output frequency (100 Hz) when the last three digits of the VCO frequency correspond with the last three digits that were dialed-in.

4.2.4 Divide-by-N Counter (CH-A12)

The function of the ÷N circuits on printed circuit board 0089 is to count the frequency of the VCO output signal and to produce a 100-Hz pulses output signal.

As has been stated, the VCO must produce a signal with a frequency of 6.3456 MHz for a dialed-in frequency of 123.456 MHz. The VCO sinewave output is accepted by the clock pulse-forming network (Figures 4-3 and 6-4). In the example, the ÷N Counter must count 6,345,600 pulses per second and produce a signal of 100 pulses per second (100 Hz). This means that for every 63,456 input (clock) pulses, the counter must produce one output pulse. The command, "divide-by-N" in this case means "divide by 63,456".

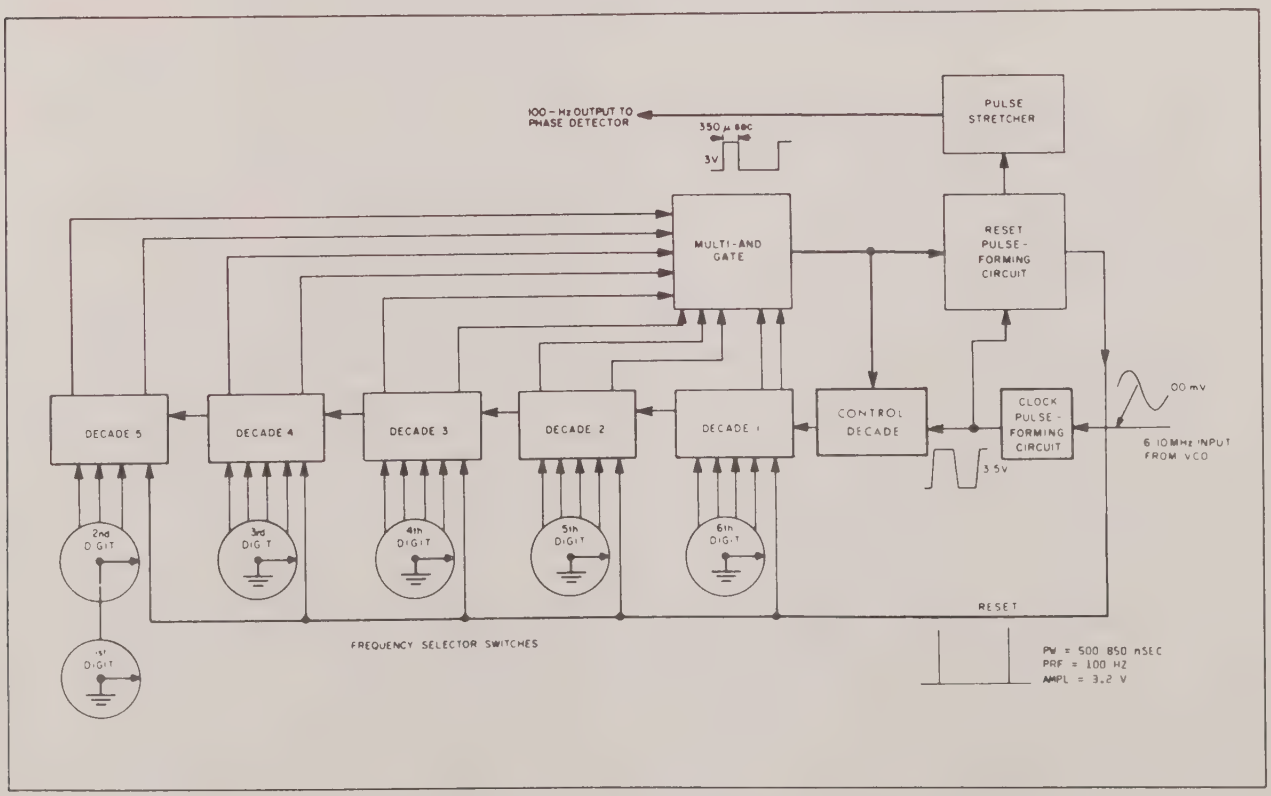


Figure 4-3. Divide-by-N Counter, Simplified Block Diagram

The ÷N Counter consists mainly of decade counters and gating circuits. There are five counting decades (plus one control decade), all identical and each capable of counting to ten (a decade). For each ten-count a decade produces one output pulse. Thus, if the first decade counts to ten and produces an output pulse and the second decade counts the output pulses of the first decade to produce its one output pulse, the second decade produces one pulse for every one-hundred pulses counted by the first decade. With a third, fourth and fifth decade, the counter as a whole then counts 100,000 before the last (fifth) decade can produce its first output pulse.

The decades count automatically, but they can only count to ten. Further, since zero is considered a count, the decades count from 0 to 9. When there is an input signal the five decades together cannot return to zero until they have counted the full count of 100,000 or, from 0 to 99,999.

To reach a count other than a full count of 99,999, for instance the 63,456-count of the example, each decade must be preset. This is done with the frequency selectors on the CE-3 front panel.

When the sixth frequency selector is turned to "6" (63,456) the first decade is preset to "3" (9-6=3); the decade is preset to a condition that is as if it has already counted 1, 2, 3 and only needs to make an additional six-count to reach 9 and complete its first ten-count. After this first, partial count (6) the decade returns to zero (not to 3) and all subsequent counts are ten counts, providing the dialed-in frequency is not changed and until the full count of 99,999 is reached.

For the example value, the other four decades are preset or "programmed" for "4" (9-5=4), "5" (9-4=5), "6" (9-3=6), and "3" (9-6=3). When "N" = 63,456 the decades are preset to 36,543 so that they need to count only 63,456 pulses to reach their first full count of 99,999.

During the last ten-count (by the first decade) all other decades will already be in "state 9" and during this last ten-count a sixth, control decade senses that the five counting decades are nearing a full count. Specifically, when the 2nd, 3rd, 4th, and 5th decades are in state 9 and the first decade reaches state 4 (five more counts to 99,999), the last five pulses are not fed to the first decade but are used in the reset pulse-forming network. The rest pulse is applied to all five counting decades to reinstate the preset condition and enable another 63,456-count.

Thus, there is one reset pulse for each 63,456 input or "clock" pulses. And, since (in this example) the VCO signal consists of 6,345,600 pulses per second (6.3456 MHz), there will be 100 reset pulses per second or, a signal with a pulse repetition frequency of 100 Hz. This signal, made up of reset pulses is also the output of the ÷N circuit which is compared with the MO signal in the Phase Detector.

In a signal that consists of between 6,000,000 pulses per second and 10,000,000 pulses per second (the VCO range is from 6 to 10 MHz) each clock pulse has a duration of between 100 and 170 nanoseconds, and since it takes the duration of five clock pulses to form the reset pulse, this reset pulse will be between 500 and 850 nanoseconds in duration.

Pulses of this short a duration, even if they occur at the correct frequency, cannot be used to make up the signal that is to be compared with the 100-Hz signal from the MO. A pulse stretching circuit is therefore used to lengthen the duration of each individual pulse to 350 microseconds.

To facilitate the determination of the phase relation between the MO signal and the ÷N signal, the stretched-pulse, 100-Hz output from the ÷N Counter is delayed. Thus, if a phase lag is detected which is more or less than the phase lag introduced by the delay circuit the VCO is not "on frequency" and a control voltage is developed to tune it.

In the preceding paragraphs reference has been made to the "state" of a decade; this refers to the combination of binary states of four flip-flops that are contained in the decade-counter IC's. Each flip-flop is either "on" or "off", it is either in binary state 0 or in binary state 1. When counting, the decades successively assume states 0 through 9 and the correlation between the state of a decade and the binary states of the flip-flops in that decade is as shown in Table 4-4.

The pre-setting of the decades is performed with the frequency selectors and consists of grounding or not grounding the flip-flops in the correct combination when the desired number is dialed. Each frequency selector (except the first and the second) is associated with a binary-coded rotary switch which is constructed such that there is one terminal connection for each flip-flop. Thus, when a digit is selected, the four flip-flops are grounded or not grounded as is appropriate for the required preset state of the decade.

Table 4-4. Relationships between the "State" of a Decade and the Binary States of its Flip-Flops

Decade State	FF-1	FF-2	FF-3	FF-4
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1

The first and second frequency selectors are both associated with the fifth decade. Because of the frequency relationship between the dialed-in frequencies and the VCO frequencies (Table 4-1) the numbers dialed-in have no direct numerical relationship with the associated preset state of the fifth decade. In the example for instance, the fourth digit dialed-in and displayed is a 3 (123,456 MHz), the fourth digit of the associated VCO frequency is also 3 (6.3456 MHz). The numerical relationship between "3" and the preset state of the decade is simply 9-3=6. The fifth and sixth digits of the dialed-in frequency are 2 and 1 (123.456 MHz); the number representing the VCO frequency has no sixth digit and the fifth digit is 6, not 2 (6.3456 MHz). Thus, there is no simple numerical relationship; instead, since the fifth digit of the VCO frequency is arbitrarily 6, 7, 8, or 9; the state of the fifth decade is 3, 2, 1, or 0. Table 4-5 shows which fifth decade state results from which combination of positions of the first and second frequency selectors. The blank blocks represent "impossible" combinations.

4.2.5 Sample-and-Hold Circuits (CH-A10)

The circuits on printed circuit board 0046 develop a d-c control voltage for the Varicap in the VCO circuit that is proportional to the phase relation between the 100-Hz output of the ÷N Counter and the 100-Hz signal that is derived from the MO output. Figure 4-4 is a block diagram of the sample-and-hold circuits. As described in 4.2.2, a pulse from the Reference Divider activates the Phase Detector and a (delayed) pulse from the ÷N Counter turns it off. When the Phase Detector output is high, it produces an input for the Ramp Generator on the 0046 Board (Q1 through Q4, Figure 6-5). The Ramp Generator produces an output with a ramp waveform.

An un-delayed pulse from the ÷N Counter activates the first Sample and Hold circuit consisting of transistors Q5, Q6 and Q7 and associated components. The first Sample and Hold circuit will remain on for the duration of the pulse from the ÷N Counter. Capacitor C9 charges to a voltage that is proportional to the phase difference between ÷N output and the MO signal.

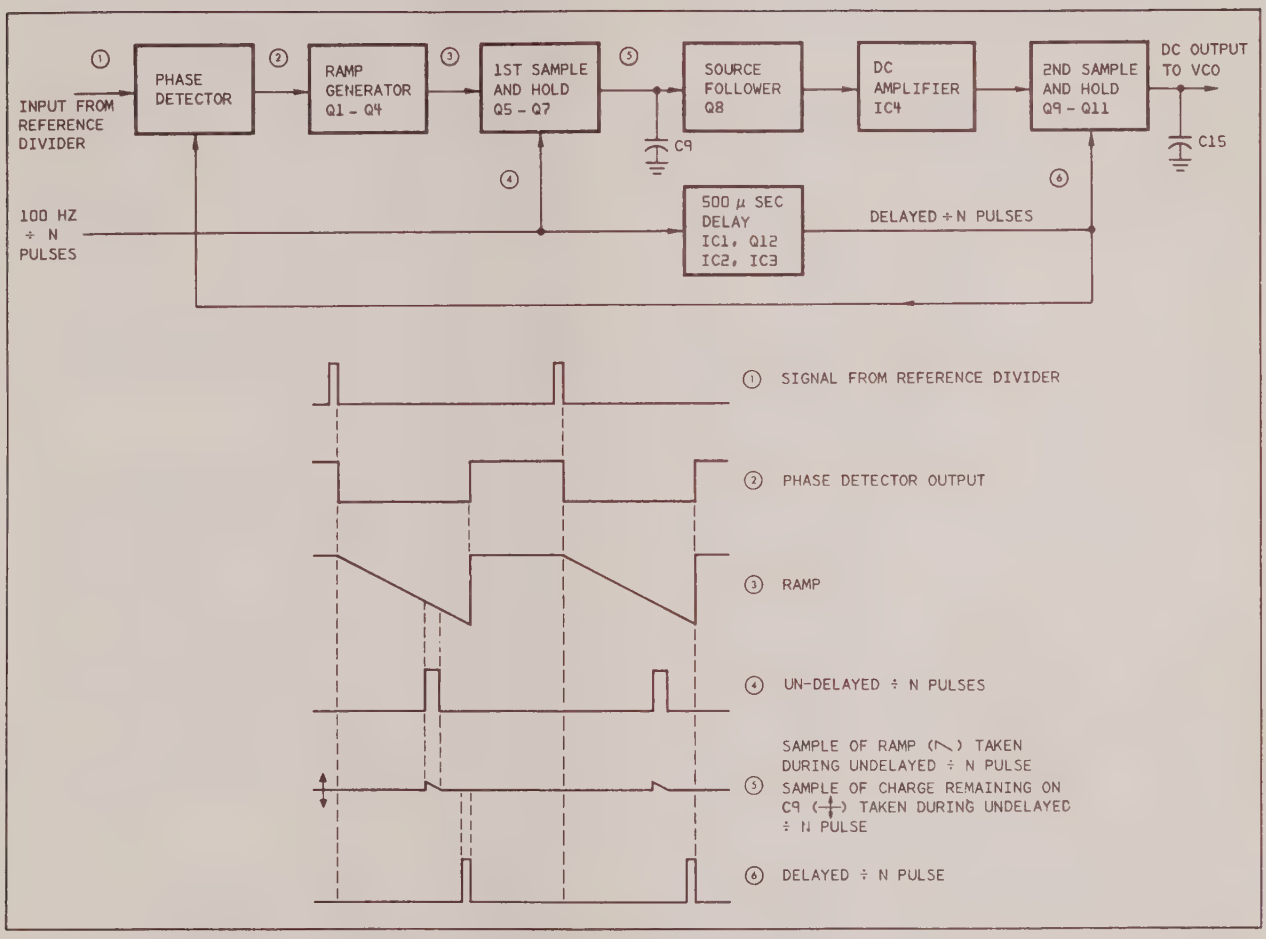

INPUT FROM REFERENCE DIVIDER
PHASE DETECTOR
RAMP GENERATOR Q1 - Q4
1ST SAMPLE AND HOLD Q5 - Q7
SOURCE FOLLOWER Q8
DC AMPLIFIER IC4
2ND SAMPLE AND HOLD Q9 - Q11
DC OUTPUT TO VCO
C9
C15
100 HZ ÷ N PULSES
500 μ SEC DELAY IC1, Q12 IC2, IC3
DELAYED ÷ N PULSES
① SIGNAL FROM REFERENCE DIVIDER
② PHASE DETECTOR OUTPUT
③ RAMP
④ UN-DELAYED ÷ N PULSES
SAMPLE OF RAMP (↖) TAKEN DURING UNDELAYED ÷ N PULSE
⑤ SAMPLE OF CHARGE REMAINING ON C9 (⊣⊢) TAKEN DURING UNDELAYED ÷ N PULSE
⑥ DELAYED ÷ N PULSE

Figure 4-4. Sample-and-Hold Circuits, Simplified Block Diagram

Table 4-5. Fifth-Decade States Preset by First and Second Frequency Selectors

1st digit 2nd digit	0	1	2	3	4	5	6	7	8	9
0, 1			"3"	"2"	"3"	"2"	"1"	"0"		
4						"3"	"2"	"3"	"2"	"1"
5	"2"	"1"								
IF	"3"	"2"	"1"	"0"						

This voltage decreases linearly as a result of the ramp-forming action of the circuit but between sampling pulses (that is, between two undelayed ÷N pulses) the capacitor remains charged with the potential that is indicative of the phase relation between the two 100-Hz signals.

The voltage on C9 is not suitable as a control voltage for the VCO Varicap because of the ripple that is present (not indicated in idealized waveforms shown in the lower part of Figure 4-4). The delayed ÷N pulse therefore activates a second sampling circuit so that a sample can be taken of the charge that remains on C9 between undelayed ÷N pulses. First, however, a source follower, Q8, fixes the amount of charge that remains and an operational amplifier, IC4, approximately doubles this voltage.

The second Sample and Hold circuit, consisting of Q9, Q10, Q11, samples the output of IC4 and applies this sample across C15. The fact that a representative potential is sampled and not the actual potential on C9, is indicated in the timing diagram of Figure 4-4 by the vertically opposed arrows (line 5). The result is a control voltage, available at board-pin 21 that is suitable for "fine-tuning" the VCO.

The schematic diagram (Figure 6-5) shows that the Ramp Generator consists of an inverter (Q1) and a bootstrap timing circuit (Q2, Q3, Q4). Its output is a sawtooth or ramp. The ÷N pulse, amplified by Q6 and Q7, turns field-effect transistor Q5 on for the duration of the pulse which causes a small segment of the ramp to be passed by Q5. Capacitor C9 charges to the voltage represented by the lowest point of this ramp segment.

The Source Follower, metal-oxide-semiconductor (MOS) field-effect transistor Q8, places a very high shunt resistance across C9 so that a large part of the charge on C9 remains. An operational amplifier (inverter), IC4, with a fixed gain of 2.1 raises the potential of the remaining charge.

The second sample-and-hold circuit (Q9, Q10, Q11) is virtually identical to the first and its action is the same.

The 500-microsecond delay circuit is shown in the lower part of Figure 6-5. Integrated circuit, IC2, is connected as a one-shot multivibrator which is triggered by the leading edge of the un-delayed ÷N pulse and puts out a voltage pulse of approximately 500 microseconds duration. This pulse is inverted by Q12 and the leading edge of the inverted pulse is used to trigger a second one-shot multivibrator, IC3. The output of IC3 is a pulse approximately 250 microseconds wide, which in the foregoing discussion has been referred to as the "delayed ÷N" pulse. Integrated circuit IC4 acts as a buffer with two outputs. One output drives Q11 of the second sample-and-hold circuit and the other goes to the reference divider and phase detector board.

4.2.6 40-MHz, 43-MHz, and 46-MHz Filters (CH-A18)

The circuits on board 0072 convert 20-MHz and 3-MHz MO outputs to signals with frequencies of 40, 43, and 46 MHz.

The 20-MHz signal from the MO is doubled by Q1 (Figure 6-6). Isolation amplifier Q7 feeds the result of this doubling to the Balanced Mixer (via board-pin 15) but only when d-c power is applied. This d-c power is applied when the first frequency selector is in the "0", "1", "4", or the "IF" position.

In addition, the 40-MHz output of Q1 is fed through amplifier, Q2, to mixer, CR2/CR3, where it is combined with a 3-MHz signal from the MO. The output of this mixer contains both 40 MHz + 3 MHz = 43 MHz and 40 MHz + 2nd harmonic of 3 MHz = 46 MHz. The output containing the two frequencies is filtered by an active filter (Q3 through Q6) to a 43 MHz-only signal which is available at board-pin 22. A similar filter, consisting of Q8, Q9, and Q10, makes a 46 MHz signal available at board-pin 2.

4.2.7 33-MHz, 42-MHz Filters, and Audio Amplifier (CH-A16)

The circuits on printed circuit board 0064 develop 33-MHz and 42-MHz outputs via board-pins 21 and 2 (Figure 6-7) to the 33 x 10 Multiplier and the Balanced Mixer. In addition, an integrated circuit, IC1 has been

installed on this board to provide audio amplification for the signal originating on the 2nd IF and Discriminator Board.

A Pulse Shaper, IC2, accepts a 3-MHz signal from the MO and changes it into a signal of the same frequency but with narrower pulses (10 nanoseconds). Transistors Q1 through Q4 are connected as a filter that passes and amplifies only the 42 MHz content of the output of IC2. This 42-MHz Filter is activated when the first frequency selector is in position "5".

Transistors Q5 through Q8 form a similar filter that is tuned to 33 MHz and is activated only when the first frequency selector is in position "1".

4.2.8 Balanced Mixer (CH-A15)

The circuits on board 0065 add either a 40-MHz or a 42-MHz signal to an input from the VCO. The 40-MHz signal comes from the 40-MHz, 43-MHz, and 46-MHz Filters Board and the 42-MHz signal comes from the 33-MHz and 42-MHz Filters and Audio Amplifier Board. Both inputs are applied to board-pin 2 but only one of the sources is ever activated at a time. Activation of both sources is impossible because of the way in which the frequency selectors have been wired.

Driver, Q1, (Figure 6-8) provides amplification of whichever input is received and its output is applied to the double, balanced mixer (primary of mixer transformer, T1). The input from the VCO enters the board at board-pin 11 and is amplified by IC1; the gain is automatically controlled by a d-c signal from a level detector on the 46-to-50.2 MHz Multiplier board. This Automatic Level Control (ALC) signal enters the board at board-pin 14 and is amplified by IC2 before being applied to IC1. The controlled output of IC1 is then fed to the secondary of transformer T2. This secondary together with the secondary of T1, CR1, CR2, CR3, and CR4 forms the double balanced mixer. The output of T2 is fed to a Bandpass Amplifier which passes and amplifies only the frequencies between 46 and 50.2 MHz. The Bandpass Amplifier provides two outputs, a normal output at board-pin 21 and an attenuator output at board-pin 18.

4.2.9 46-to-50 MHz, 33-MHz, and 43-MHz Multipliers (CH-A2, CH-A3, CH-A4)

The 46 to 50.2 Multiplier is on printed circuit board 0066. The 33-MHz and 43-MHz Multipliers are on identical boards, 0067, but components are different. Operation of all three multipliers is the same except that the 46-to-50.2 Multiplier uses a full-wave frequency doubler.

While being applied to the 46 to 50.2 Multiplier (Figure 6-9), part of the input signal from the Balanced Mixer (via CH-A2-J1) is rectified by CR1 to produce a d-c voltage proportional to the amplitude of the incoming signal. This d-c voltage is fed back to the Balanced Mixer via pass-through capacitor C2 in the wall of the CH-A2 container.

In the 46 to 50.2 Multiplier the frequency of the signal from the Balanced Mixer is doubled and applied to snap diode, CR4, a nonlinear device with a very fast turn-off characteristic that makes it an efficient generator of harmonics. An in-line coaxial filter (Fil-1) is connected by BNC connector to CH-A2-J2, to ensure that only the fifth harmonics of the frequencies fed to CR4 are passed. The 46-to-50.2 Multiplier is activated whenever the CE-3 is in operation.

The 33-MHz and 43-MHz Multipliers are activated only when the frequency selectors are in certain positions. Both Multipliers (Figures 6-10 and 6-11) use amplifiers tuned to the appropriate frequency. Operation of all other circuit stages are analogous to those discussed above.

4.2.10 Triplexer (CH-A1)

The Triplexer should be replaced as a unit. It contains PC boards that combine the RF signals which produce the proper relationships between dialed-in frequencies and the outputs of the Frequency Synthesizer. These relationships are achieved by mixing the mixed and multiplied VCO signal with the

correct fixed-frequency signal (330 MHz or 430 MHz). Actual mixing takes place in the RF plug-in accessory that is being used or in the Signal Generator Mixer (when the CE-3 is used as a Signal Generator) depending on the position of a coaxial relay, CH-K1. This coaxial relay is actuated by the function switch, FP-SW8. Table 4-6 shows the dialed-in frequencies and the Triplexer outputs that are appropriate for these ranges. Figure 6-12 shows how the Triplexer is connected to the various other assemblies.

Table 4-6. Triplexer Outputs

Dialed-in Range	Triplexer* Output
20 to 80 MHz	460 to 402 MHz and 430 MHz
120 to 180 MHz	460 to 502 MHz and 330 MHz
450 to 512 MHz	460 to 502 MHz and None

*The multiplied and filtered Balanced Mixer output and the fixed frequency signal (when appropriate) are present in the Triplexer output at the same time.

4.2.11 6-db Fixed Attenuator (CH-A22)

In 4.2.10 it has been stated that the output of the Triplexer was fed to the RF plug-in or to the Signal Generator Mixer, depending on the position of coaxial relay CH-K1. Different levels are, however, required for these two units. Therefore, a 6-db fixed attenuator has been placed in the signal path between the coaxial relay and the LO input to the RF plug-in.

The 6-db attenuator consists of a metal box containing one resistor (27Ω, 5%) in series with the signal path and two resistors (180Ω, 5%) to ground. BNC connectors are provided for connection of the coaxial cables from the coaxial relay and to the RF plug-in, coaxial receptacle, CH-J5. Figure 6-12 shows how the 6-db attenuator is connected.

4.2.12 1kHz-to-4MHz Mixer and 9.9-MHz Filter (CH-A8)

The circuits on printed circuit board 0062 accept a 46- to 50.2-MHz signal from the Balanced Mixer (board-pin 4) and a 46-MHz signal from the 46-MHz filter (board-pin 2). The two inputs are mixed to produce signals with frequencies in the 0-to-4 MHz, "IF" range. As shown in Figure 6-13, upper part, the 46-MHz signal is amplified (Q1) before being applied to the mixer (T1, CR1, CR2). The signal with a frequency between 46 and 50.2 MHz is not amplified but applied directly to the secondary of mixer transformer, T1 (the fixed frequency having been applied to the primary of T1).

The frequency that results from mixing is in the 1 kHz- to 4-MHz range. The signal is amplified (Q2, Q3) and delivered through emitter follower, Q4, to board-pin 10. When the front-panel IF FREQUENCIES switch is placed in the 4- to 40-MHz position, a feedback path between Q3 and Q2 through R37 and R18 is removed by grounding the junction of the two resistors via board-pin 8. This increases the gain of the amplifier and, consequently, the 4- to 40-MHz content of the output signal is raised to a usable level.

4.3 Second-IF and Discriminator Circuits (CH-A20)

These circuits are all on printed circuit board 0054 but for ease of discussion they have been divided in functional elements as follows:

1. Second Mixer, which amplifies the 10-MHz signal from the RF plug-in that is being used, amplifies the 9.9-MHz Frequency Synthesizer, and mixes these two signals to produce a second IF which is nominally 100 kHz;
2. Discriminator/Frequency-Error Detector, which delivers a voltage to the FREQUENCY meter when the second IF is not exactly 100 kHz;
3. Audio circuits, which demodulate the 100 kHz signal and deliver the AF signal to the audio amplifier on the 0064 board and to either a Deviation Meter or an Oscilloscope plug-in;

4. Signal-Level Detector produces a disabling voltage to keep the Frequency-Error Detector turned off until a sufficiently strong signal is received by the CE-3, and then enables the Frequency-Error Detector and lights the SIGNAL LEVEL indicator when the signal level is high enough for satisfactory measurement.

Figure 4-5 is a block diagram of the Second IF and Discriminator circuits and Figure 6-14 is the schematic.

4.3.1 Second Mixer

The 10-MHz signal from the RF plug-in (Broadband Mixer or Preselector) is amplified by tuned amplifier IC1 and applied to IC2. The 9.9-MHz signal from the Frequency Synthesizer is amplified by tuned amplifier Q1 and also applied to IC2. Integrated circuit , IC2, is connected as a mixer and its output is fed through a lowpass filter to Q2 in the Frequency-Error Detector.

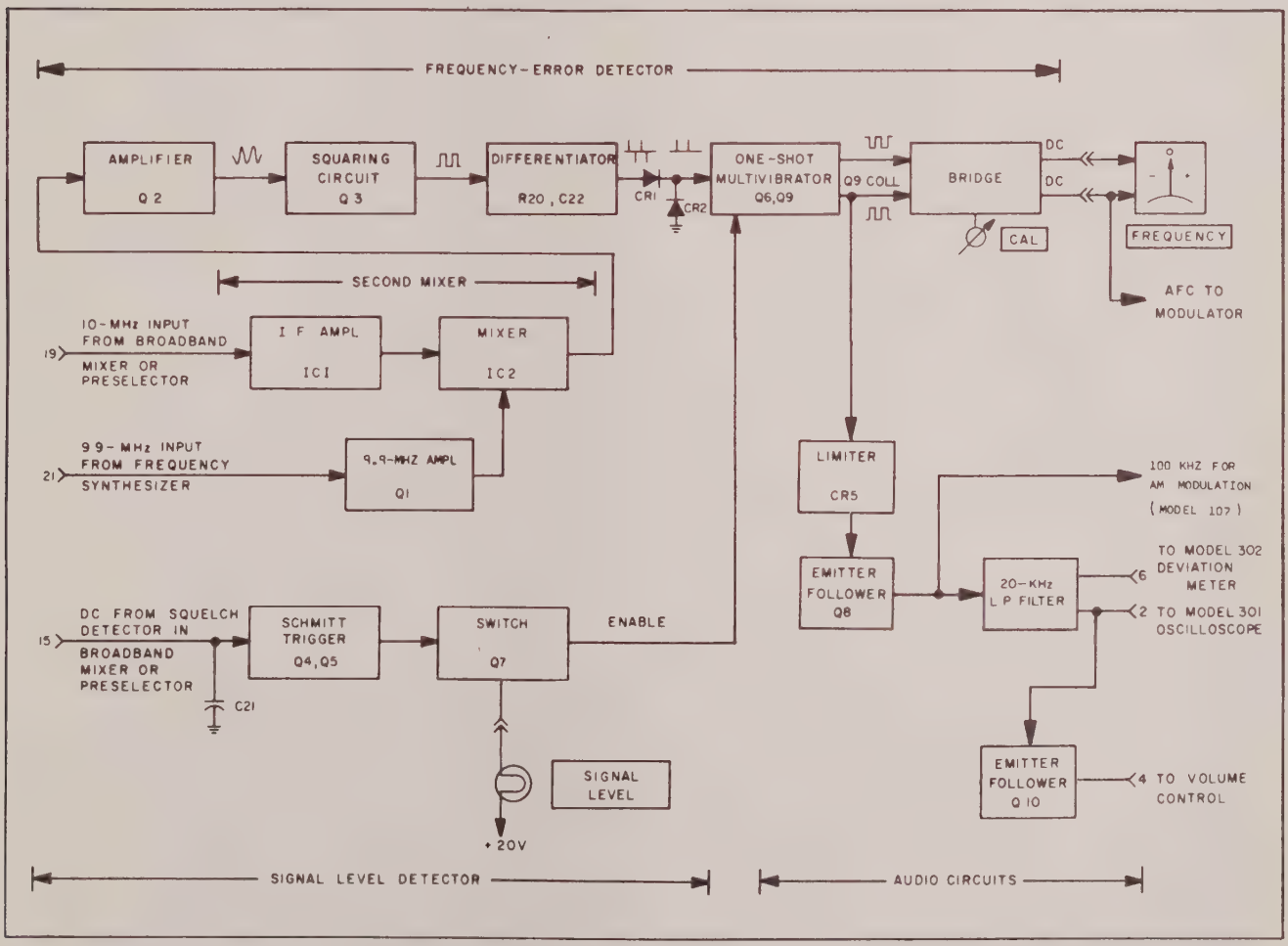


Figure 4-5. Second-IF and Discriminator Circuits, Simplified Block Diagram

4.3.2 Frequency-Error Detector

The 100-kHz signal from IC2 is amplified by Q2 and applied to a squaring circuit (Q3). The resulting 100-kHz square wave is differentiated (R20/C22) and the positive pulses are passed by CR1 to trigger a one-shot multivibrator (Q6, Q9). The multivibrator can operate only when the received signal is strong enough for the Signal-Level Detector to furnish an enabling ground through Q7. The multivibrator output is a pulse with a width that is one-half the period of a 100-kHz square wave (5 microseconds). This pulse width remains 5 microseconds throughout a frequency-error range of from 75 to 125 kHz. The outputs from the collectors of Q6 and Q9 are fed to a bridge circuit.

The bridge circuit includes the FREQUENCY meter on the front panel and a simplified schematic of the metering or bridge circuit is shown in Figure 4-6. In this figure transistors Q6 and Q9 are depicted as switches, one of which is always off when the other one is on.

For most frequencies that can be selected, the LO frequency is 10 MHz below the dialed-in frequency (Table 4-1). When this is true relay FP-K1 on the Frequency Meter Board (FP-A1, 0052, Figure 6-15) is de-energized and the input from the Q9 side of the Frequency-Error Detector is applied to the positive side of the meter.

When the first frequency selector is in position "0", while the second frequency selector is in positions "2" or "3"; and also when the first selector is in position "4", while the second selector is in positions "5" or "6", the LO frequency is 10 MHz higher than the dialed-in frequency. Under these circumstances FP-K1 is energized and the input from the Q6 side of the Frequency-Error Detector is applied to the positive terminal of the meter. Regardless of whether the relay is energized or de-energized, however, the action of the circuit is the same.

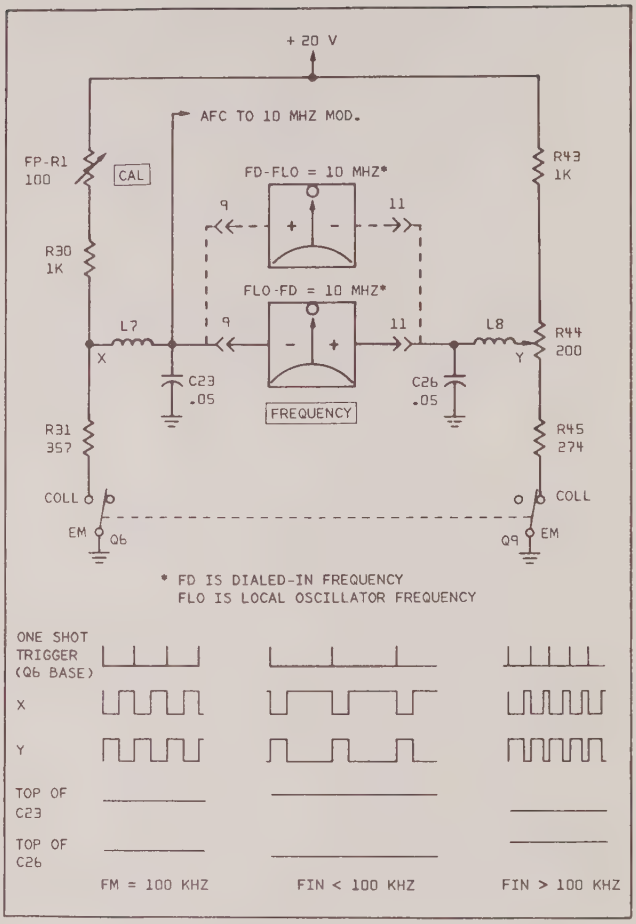


Figure 4-6. Frequency-Meter Bridge Circuit, Simplified Schematic

For the conditions shown in Figure 4-6, the switch that is on (transistor Q9) causes the voltage at point "Y" to drop to a minimum (about 6 volts) and the "switch" that is off permits the voltage at point "X" to rise to a maximum (about 20 volts). The lower part of Figure 4-6 shows the waveforms at points "X" and "Y". The time a "switch" is on equals the time it is off only when the input frequency is exactly 100 kHz; that is, when the pulse durations equal the times between pulses and represent a 50% duty cycle.

When the pulsed signals at "X" and "Y" have a 50% duty cycle, the L/C combinations L7/C23 and L8/C26, which are averaging networks, apply the same potential to both sides of the meter.

When the input-signal frequency is not exactly 100 kHz, but higher or lower, one of the "switches" is on a shorter time than it is off. Therefore, the other "switch" is on longer than it is off. Neither the duty cycle of the waveform at "X", nor the one at "Y" is 50% and as a result the average voltages at these points are not equal. A difference of potential exists across the meter and the meter needle deflects. Since needle deflection is proportional to the difference in potential across the meter and since this potential is proportional to the difference between 100 kHz and the frequency of the input signal, the meter dial can (and is) calibrated directly in kHz.

Two controls have been provided for zeroing the meter: R44 on board 0054 and the CAL control (FP-R1, Figure 6-15). In addition, each of the three meter ranges (0 to 1.5 kHz, 0 to 5 kHz, and 0 to 15 kHz) can be separately adjusted by one of three potentiometers (FP-A1-R2, -R4, and -R6).

The three meter ranges are selected by means of the lever switch directly under the FREQUENCY meter on the front panel. Each of the three range-adjusting potentiometers is in series with a fixed-value resistor, to provide meter readings in the selected range, and also with a (common) pair of diodes (FP-A1-CR1 and CR2), which provides overload protection.

Meter-range selection is only possible when the function switch is in the FREQ. DEV/-MEASURE position and the CE-3 is being used as a FM Communications Monitor. When the function switch is in "FM", "CW", or "CAL", no range selection is possible. In "FM" the meter input is always through FP-A1-R3 and -R4 and the meter indicates in the 0- to 5-kHz range. In "CW" and in "CAL", the meter input is through FP-A1-R5 and -R6 and only the 0- to 1.5-kHz range is effective.

The voltage at the junction of L7 and C23 (Figure 6-14) is, as has been mentioned previously, indicative of the frequency error (difference from 100 kHz). This potential is applied to the meter but it is also used as an Automatic-Frequency-Control (AFC) voltage. For this purpose it is applied via pin 9 of board 0054 and via the front-panel function switch (FP-SW-D2) to the Varicap in the oscillator circuit on the Modulator Board.

4.3.3 Audio Circuits

In the explanation of the metering circuit, mention was made of the manner in which the average voltages appearing across the averaging network relate to the duty cycles of the pulses signals and cause meter-needle deflection. If the incoming signal is frequency-modulated the average voltages at points "X" and "Y" also vary at the modulation rate. This variation does not affect the needle deflection because of the filtering action of the averaging circuits (L7/C23, L8/C26).

The modulation which is still present at the collector of Q9, (100 kHz ± error + modulation) is fed through limiter, CR5 to the audio circuits consisting of emitter follower, Q8, a lowpass filter, and another emitter follower, Q10. The audio signal to the volume control and the speaker passes through Q8, the lowpass filter, Q10 and board-pin 4; the audio to the Deviation Meter or Oscilloscope passes through Q8, the lowpass filter and board-pin 2. The output at board-pin 6 is taken off at a point in the signal path where the 100 kHz component is still present. This output is made available at the RF plug-in receptacle (CH-J4-12) and the accessory plug-in receptacle on the left side of the CE-3, (CH-J1-3).

4.3.4 Signal-Level Detector

The RF plug-ins or frontends (Broadband Mixer and Preselectors) incorporate a squelch circuit which produces a d-c voltage that is proportional to received-signal strength. This d-c voltage is applied to a Schmitt Trigger consisting of Q4 and Q5, which is set to fire when the signal output of the First IF Amplifier (in the frontend) is approximately

60 millivolts. When the Schmitt Trigger fires, it turns switching transistor Q7 on, which enables the Frequency-Error Detector and also lights the SIGNAL LEVEL indicator to announce that the signal strength is great enough for reliable measurement. The Schmitt Trigger remains in the "fired" state as long as the signal level is above the critical level.

4.4 Signal-Generating Circuits

Signals in frequency ranges of from 20 to 80 MHz, from 120 to 180 MHz, and from 450 to 512 MHz are generated by mixing a CW- or FM-10-MHz signal with a signal from the Frequency Synthesizer. The frequency of the Synthesizer output is determined by the settings of the frequency selectors. The circuits involved in the generation of signals in the above mentioned ranges are the 10-MHz Modulator and the Signal Generator Mixer.

The IF frequencies that can be obtained from the CE-3 are direct outputs of the Frequency Synthesizer and their generation is discussed in the appropriate section.

4.4.1 10-MHz Modulator (CH-A14)

The purpose of the circuits on printed circuit board 0062 is to frequency modulate the 10-MHz input to the Signal Generator Mixer. This modulation can be derived from a 1-kHz signal from the Frequency Synthesizer or from an external source (between 60 Hz and 20 kHz). Figure 6-16 is the schematic of the 10-MHz Modulator.

The 10-MHz signal is generated by a voltage controlled oscillator consisting of Q1 and associated components. Its frequency is set to exactly 10 MHz with the FM. CAL. control; the FREQUENCY meter indicates "0" when the adjustment to this frequency is correct. The FM. CAL. control adjusts the d-c voltage applied to Varicap, CR3, in the frequency-determining portion of the oscillator circuit. The oscillator is kept at 10 MHz by an AFC voltage from the Frequency-Error Detector (CH-A20), via the front-panel function switch, FP-SW-D2.

The tuned circuit of the oscillator consists of C8, C9, L3, C10, C11, and Varicap, CR3. The capacitance of the Varicap varies with the voltage across it and this voltage has two components: the AFC voltage as adjusted by the FM. CAL. control and the modulating signal from the Frequency Synthesizer or from an external source.

The 1-kHz modulating signal from the Frequency Synthesizer is accepted at board-pin 2 and amplified by integrated circuit IC1. The output of IC1 is fed through board-pin 4 to the DEV. ADJ. control on the front panel, but only if this integrated circuit is activated by the FM. MOD. switch (in the INT. position). When this switch is in the EXT. position, an external modulating signal applied at the EXT. connector on the front panel is fed directly to the DEV. ADJ. control, FP-R4.

Whatever the source of modulating signal, this potentiometer (FP-R4) permits adjusting the level of modulating signal applied to Varicap, CR3, thus adjusting the amount of frequency deviation of the generated signal about a center frequency of 10 MHz. Transistors Q2, Q3, and Q4 are connected as amplifier stages to provide the required signal level.

When the front panel function switch (FP-SW8) is turned to either the CW or the CAL position, the 20-volt supply to oscillator/modulator, Q1, and to amplifier Q2 is disconnected and the 10-MHz harmonic generator in the Frequency Synthesizer is activated to supply an unmodulated 10-MHz signal. This signal is accepted at board-pin 15 and directed, without amplification to board-pin 17. From board-pin 17 this signal is fed through the RF plug-in receptacle and two stages of amplification in whichever frontend is being used, back through the RF plug-in receptacle to the Second IF and Discriminator board. Resistor R44 in the Frequency-Error Detector board (Figure 6-14), in conjunction with the CAL potentiometer, FP-R1 (actuated by the small red knob concentric with the function-switch knob) permits adjusting the FREQUENCY meter circuit to indicate Zero when a known 10 MHz signal is applied.

When the function switch is in the CW position the input to amplifier stage Q3 is not from Q2 (disabled by disconnecting the +20 volts) but from the Frequency Synthesizer (via board-pin 15). In the FM position of the function switch the 20-volt supply connection is restored and a modulated signal passes through Q3 and Q4. In the FM- and CW-signal-generating modes, the Modulator output is fed through the signal-generation attenuator to the Signal Generator Mixer. The attenuator is calibrated in terms of voltage-level at the output of a 20-db fixed attenuator connected to the SIGNAL GEN/OUT connector. Without adjustment, slightly different output voltages would be produced by the Signal Generator Mixer for each of the CE-3 frequency bands, for a given 10-MHz input signal. Therefore, the Modulator output level must be slightly different for each of these bands. To accomplish this a different bias is applied to Q4, depending on whether 430 MHz, 330 MHz or nothing is added to the frequency of the Balanced Mixer output (as has been stated, this is dependent on the setting of the first frequency selector). The values of bias are individually set by potentiometers R6, R7, and R8 on the Modulator board.

The 1-kHz signal used to modulate the 10 MHz signal is also available for external use at the 1-kHz-OUT front-panel connector. Transistors Q5 and Q6 are connected as audio stages to provide a usable level of 1-kHz signal for external use. (The FM MOD. switch must be in the INT. position.)

4.4.2 Signal-Generator Mixer (CH-A7)

The purpose of the circuits in the CH-A7 assembly is to mix the LO signal from the Frequency Synthesizer (which is the result of adding a fixed frequency to the output of the Balanced Mixer) with a 10-MHz signal. This mixing is to produce an output signal with the frequency that was dialed-in on the front panel so that it will be available at the SIGNAL GEN. OUT connector. And, as has been stated, for frequency measurement the frequency-synthesizer output has a frequency equal to the dialed-in frequency ±10 MHz. Figure 6-17 shows the untuned diode-mixer circuit with which this mixing is accomplished.

4.5 Power Supplies

The power supply circuits and components are distributed over two printed circuit boards, the main chassis, center portion, and the rear panel. The rectifier and filter circuits (RP-A1) are on board 0084, which is mounted on the rear panel; the regulator circuits (CH-A19, board 0082) are on a regular, plug-in type board, 0082, series regulator transistors CH-Q1, CH-Q2, and CH-Q3 are mounted on the center, upright portion of the main chassis; and the power transformer is mounted on the rear panel. For ease of following the circuit, all elements are represented in one schematic, Figure 6-18. As can be seen there are, in reality, three separate power supplies, one for each of the regulated voltage (+5, +20, and -12) required.

Three separate windings of power transformer, RP-T1, supply a-c power to the three bridge rectifiers on board 0084. The output of each rectifier is fused, filtered by a single capacitor, and fed to the associated regulator circuit board 0082.

The +5-volt regulator is a conventional series regulator with sampling elements (R14, R16), a voltage adjust potentiometer (R15), a comparison element (Q9), a Zener-diode reference element (CR4), and a regulator transistor (CH-Q2). Voltage for the reference element is supplied by the +20-volt regulator. Transistor Q7, on the board, is a current amplifier which provides the proper base current for transistor CH-Q2 on the main chassis.

Transistor Q8 together with CR3 and R11 provides overload protection by limiting the current through CH-Q2; Zener-diode CR5 provides protection against excessive voltage.

The +20-volt and the -12-volt regulators are identical except for component values. The +20-volt regulator consists of sampling elements (R8, R10), voltage adjust (R9), comparison elements Q5 and Q6 (differential amplifiers), d-c amplifier Q1, a Zener-diode reference element (CR2), and regulator transistor CH-Q1. Current protection is provided as described for the +5-volt regulator.

4.6 Miscellaneous Circuits

4.6.1 Decimal- and MHz/kHz/Hz Switching Circuits (CH-A5)

The circuits on printed circuit board 0069 apply power to the proper decimal lights in the frequency display and to the light that indicates the appropriate units in which the frequency is being displayed. When the Model 308 Decade Frequency Divider is plugged into the CE-3, control over the decimal lights originates in this unit.

Figure 6-19 is the schematic and Figure 4-7 is the function diagram of the switching circuits. An 8.5vac input from transformer RP-T1 is rectified to produce 12 volts dc.

When the Model 308 is not plugged into the CE-3, the base/emitter junction of Q1 is forward-biased. Since the base of Q1 has no connection to the negative side of the -12-volt power supply, this transistor saturates and turns on Q2 and the MHz light in its collector circuit. As long as Q2 is on there is a connection between the wiper of FP-SW1 and the negative terminal of the -12-volt power supply. When this switch, associated with the first frequency selector, is in the "0", "1", "4", or "5" position, the third decimal light has a negative return and will be on. If the first frequency selector is in the "IF" position, the negative connection is made via the IF FREQUENCIES range switch. When this switch is in the 0-to-4 MHz position, the second decimal will be on; in the 4- to 40-MHz position, the third decimal light will be on.

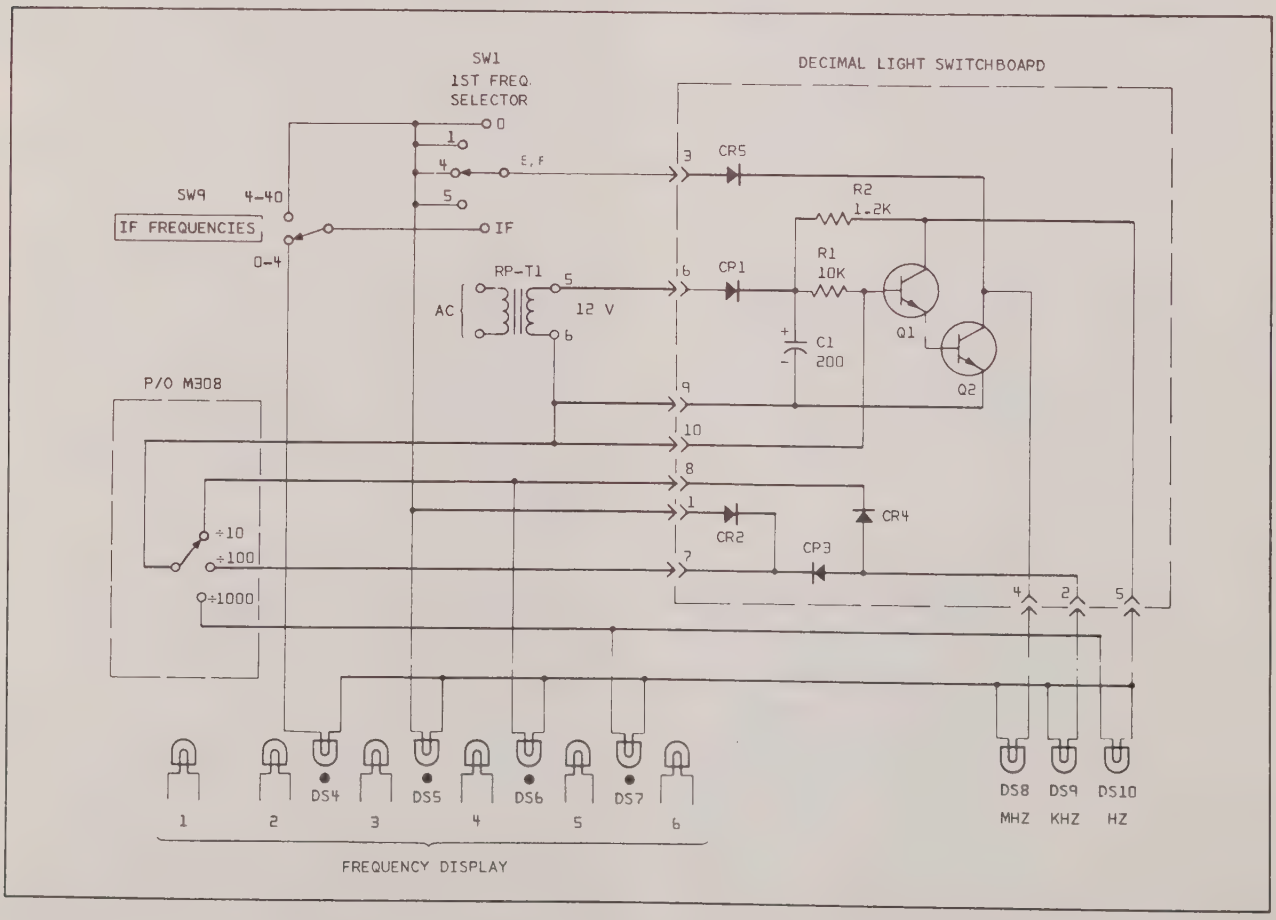


Figure 4-7. Decimal-Light Circuit, Functional Diagram

When the Model 308 Decade Frequency Divider is plugged in, the base of Q1 is permanently connected to the negative terminal of the -12-volt power supply. Thus Q1, and therefore Q2 are disabled; the MHz light will be off and the IF FREQUENCIES range switch will have no effect. Selection of decimal and unit lights is controlled through the Model 308. Operation of these circuits is summarized in Table 4-7.

Table 4-7. Decimal- and MHz/kHz/Hz Lights Switching

1st Freq. Sel. Position	IF Range	Model 308 Range	Decimal ON*	Units ON	
Model 308 not installed					
0	-	-	2nd	MHz	
1	-	-	2nd	MHz	
4	-	-	2nd	MHz	
IF	0-4	-	1st	MHz	
IF	4-40	-	2nd	MHz	
Model 308 installed					
IF	0-4	÷ 10	3rd	kHz	
IF	0-4	÷ 100	2nd	kHz	
IF	0-4	÷ 1000	4th	Hz	

*The first decimal point appears between the second and third frequency selector lights, see Figure 4-8.

4.6.2 Display-Light Flasher

If a frequency which is not within one of the CE-3 frequency ranges, is selected, the display will flash on and off. Table 4-8 shows the combinations of first and second-frequency selector settings which will result in flashing.

The circuit to produce the flashing is shown as part of Figure 6-15. The switches associated with the first and second frequency selectors are wired such that the flasher is shorted out for all correct settings. This short is removed by all incorrect settings (Figure 4-8).

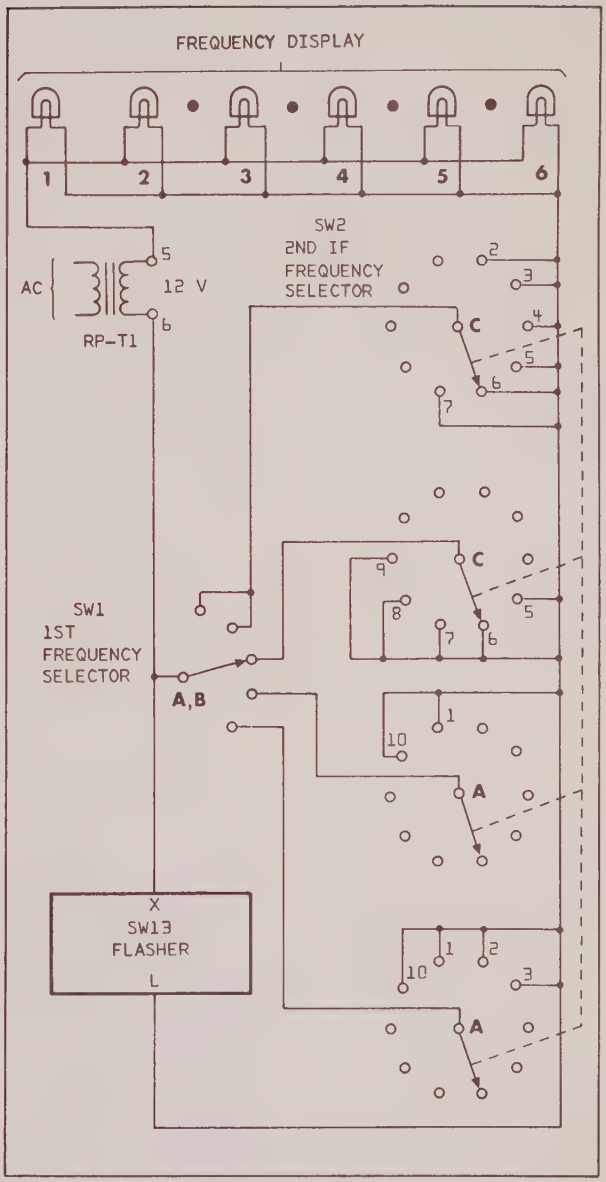


Figure 4-8. Flashing Circuit, Functional Diagram

Table 4-8. First- and Second-Frequency-Selector Settings Resulting in Flashing Display

First Frequency Selector	Second Frequency Selector
0	0, 1, 8, 9
1	0, 1, 8, 9
4	0, 1, 2, 3, 4
5	2, 3, 4, 5, 6, 7, 8, 9
IF	4, 5, 6, 7, 8, 9

SECTION 5
MAINTENANCE

5.1 General Information

This section is divided into two major subsections: "Adjustments", and Troubleshooting". It is recommended that for adjustments other than those described, the faulty subassembly or the entire instrument be returned to the Cushman Electronics, Customer Service Department for calibration and alignment.

In the following discussions it is assumed that the operator is familiar with the operating procedures described in Section 3.

The instrument should be warmed up for at least 30 minutes before any adjustment is attempted.

5.1.1 Access and Parts Location

Components in the top part of the instrument can be reached by removing the side covers. Each cover is held by six screws; the speaker leads must be disconnected before the right-hand cover can be removed completely. When the instrument is placed on its back the bottom cover can be removed. With this cover off the VCO adjustments and the plug-in printed circuit board are accessible.

A Main-Chassis Isometric Location Diagram, in Section 6.3.12, shows the location of circuit board receptacles; Figure 5-1, CE-3, Bottom View, shows the positions of the eleven plug-in printed circuit

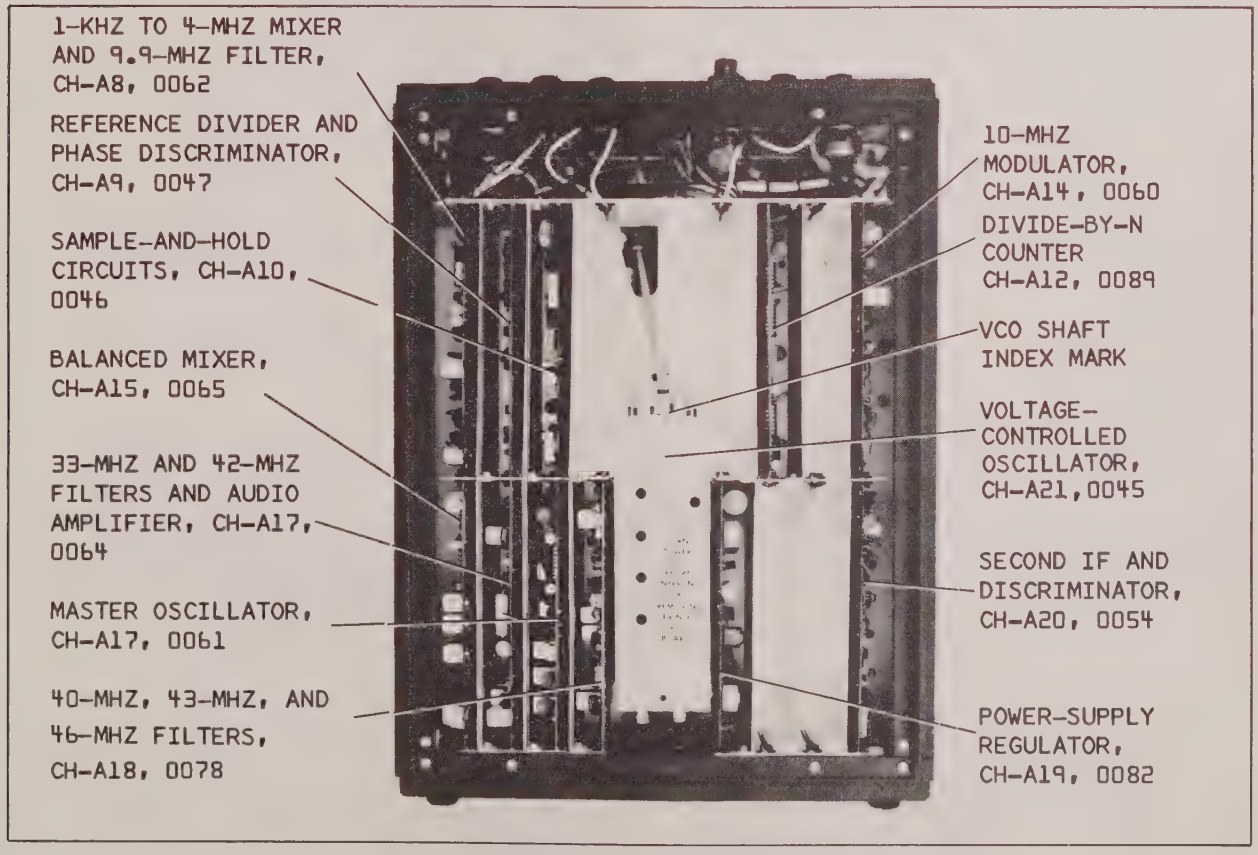

1-KHZ TO 4-MHZ MIXER AND 9.9-MHZ FILTER, CH-A8, 0062
REFERENCE DIVIDER AND PHASE DISCRIMINATOR, CH-A9, 0047
SAMPLE-AND-HOLD CIRCUITS, CH-A10, 0046
BALANCED MIXER, CH-A15, 0065
33-MHZ AND 42-MHZ FILTERS AND AUDIO AMPLIFIER, CH-A17, 0064
MASTER OSCILLATOR, CH-A17, 0061
40-MHZ, 43-MHZ, AND 46-MHZ FILTERS, CH-A18, 0078
10-MHZ MODULATOR, CH-A14, 0060
DIVIDE-BY-N COUNTER CH-A12, 0089
VCO SHAFT INDEX MARK
VOLTAGE-CONTROLLED OSCILLATOR, CH-A21, 0045
SECOND IF AND DISCRIMINATOR, CH-A20, 0054
POWER-SUPPLY REGULATOR, CH-A19, 0082

Figure 5-1. CE-3, Bottom View

boards. Figure 5-2, Troubleshooting Block Diagram, Figure 6-15, Front-Panel Wiring Diagram; and Figure 6-12, Main-Chassis Wiring Diagram facilitate point-to-point signal tracing.

In addition, Parts Lists and Component Location diagrams have been included with the Schematic Diagrams (Figures 6-1 through 6-19). In each case Parts Lists and Parts Pictorials are adjacent, or in close proximity to the associated schematic.

5.1.2 Fuses

The fuses of the three regulated power supplies are inside the CE-3 cabinet on the rectifier printed circuit board mounted in the upper left-hand corner of the rear panel. The +20-volt fuse is nearest the outside of the CE-3, the -12-volt fuse is in the center of the board, and the +5-volt fuse is the one toward the center of the CE-3. If one of these fuses has blown, the resistance between the appropriate regulator terminal and ground should be measured and compared with the corresponding, correct value given in Table 5-1. The 0.2-Amp slo-blo fuse of the 115vac input to the Oscilloscope is near the CH-J3 plug-in receptacle, opposite the rectifier printed circuit board. The main a-c fuse is accessible from the rear without removing any covers.

5.1.3 Subassembly Removal

A board extractor and an extender board (Figure 2–1) are furnished with the instrument. Before removing a board, first ascertain that the power to the boards has been disconnected; VOLUME CONTROL MUST BE IN "OFF" POSITION.

To remove the VCO assembly the instrument must be placed on its back. With the bottom cover off the VCO assembly will be seen in the center.

a. Loosen two set screws of the U-joint nearest the VCO assembly such that this U-joint will remain with the VCO assembly instead of with shaft leading to the second U-joint.

b. Loosen the three sheet metal screws (one at the top, two at the bottom) that hold the VCO assembly to the Main Chassis.

c. Move the VCO assembly down and withdraw the U-joint from the shaft. The assembly can now be placed in front of the CE-3 on the working surface.

d. Remove the cables from the VCO assembly.

To replace the VCO assembly proceed in reverse order. To ensure that the VCO is mechanically aligned proceed as follows:

a. Turn third frequency selector to "0".

b. Observe that there is a small black index mark on the short length of shaft visible between the U-joint and the VCO assembly. This mark must be positioned such that it is between the capacitor shafts marked 4 and 5 (Figures 5-1 and 5-3).

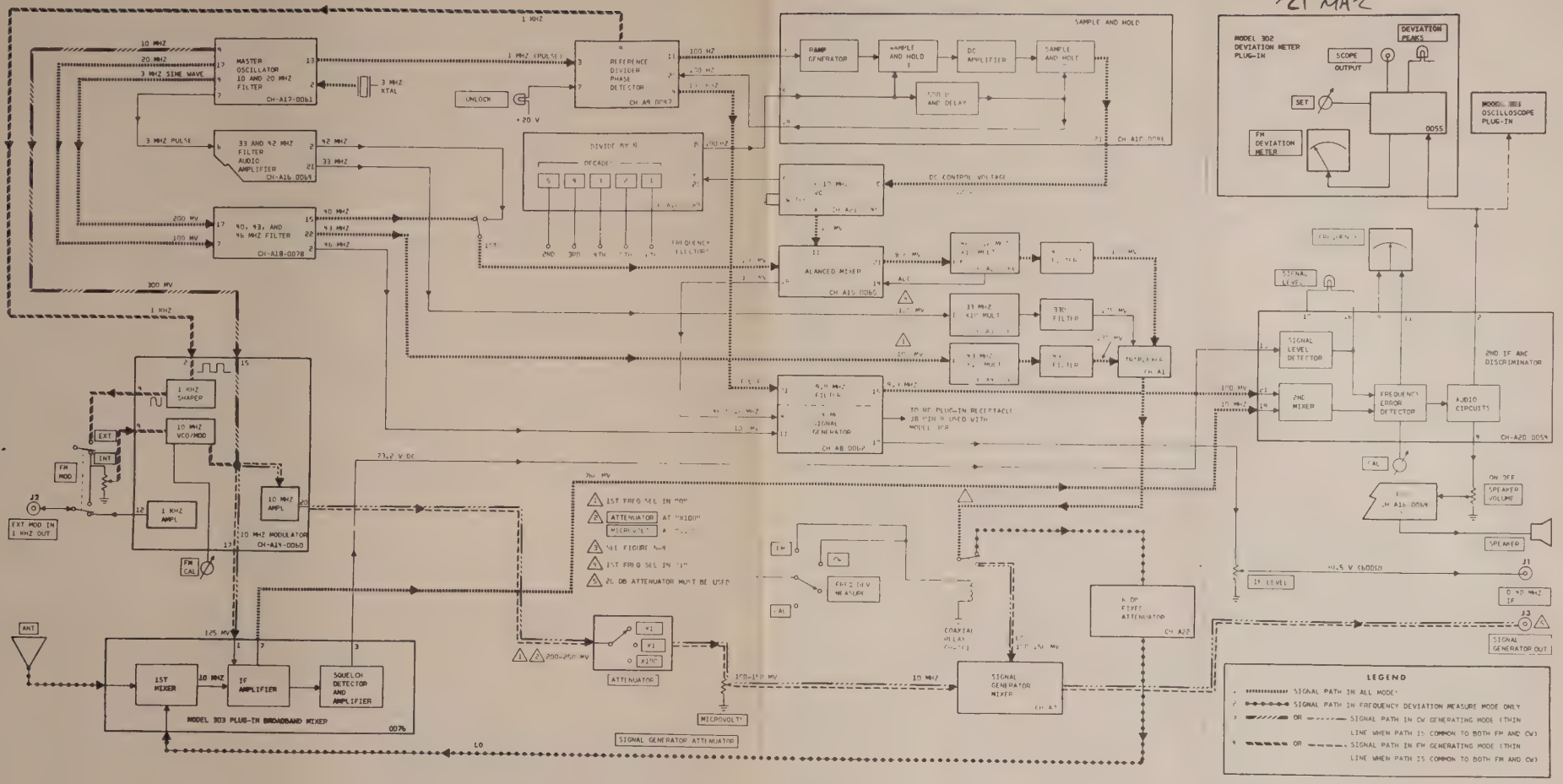


Figure 5-2. Troubleshooting Block Diagram

Table 5-1. Power-Supply Resistances to Ground

	+5V (green wire)		-12V (orange wire)		+20V (red wire)	
	Measured at	Res. (ohms)	Measured at	Res. (ohms)	Measured at	Res. (ohms)
CE-3 Monitor† (less plug-ins)	Pin 15 of RF plug-in receptacle	130Ω-200Ω*	Pin 14 of RF plug-in receptacle	140Ω	Pin 17 of RF plug-in receptacle	440Ω-480Ω
Model 301 Oscilloscope	Not used	--	Pin 14 of connector	4.5K-7.5K††	Pin 13 of connector	1.5K-1.8K*
Model 302 Deviation Meter	Not used	--	Pin 14 of connector	8.2K-8.5K*	Pin 13 of connector	1.7K
Model 303	Pin 15 of connector	3.5K*	Pin 14 of connector	500Ω	Pin 16 of connector Pin 17 of connector	1.8K-2.4K*††† 10K*
Model 304	Pin 15 of connector	1.25K-50K*	Pin 14 of connector	265Ω	Pin 16 of connector Pin 17 of connector	800Ω 22K-30K*
Model 305	Pin 15 of connector	1.25K-50K*	Pin 14 of connector	265Ω	Pin 16 of connector Pin 17 of connector	3.8K 25K-30K*
Model 308	Pin 15 of connector	460K-2K*	Pin 14 of connector	2.9K-3.8K*	Pin 17 of connector	3.9K-7.5K*

NOTE: All resistance readings taken with a Simpson 270 using RX 100 scale. All res. readings of modules taken with module removed from set.

* Depends on ohmmeter test-lead polarity.

† Dial 120.000 MHz on frequency selector using RX-100 scale. Measure resistance to chassis of supply lines.

†† Resistance readings taken with "vernier" pot in mid position.

††† Resistance readings taken with selectivity switch in "normal."

5.2 Adjustments

The internal controls mentioned in the following paragraphs are shown in Figure 5-3. All other controls such as those on the VCO assembly are for factory adjustment.

5.2.1 Power-Supply Voltages

Test Equipment Required:

a. Voltmeter, dc, 20,000Ω/Volt or better, 1% accuracy, +50 and -50 volt ranges, Simpson Model 270 or equivalent.

b. Voltmeter, ac, Hewlett-Packard Model 400D or equivalent.

NOTE

The regulated power supplies are set to within 0.5% of rated output voltage at the factory and should not be adjusted unless a voltmeter with an accuracy of at least 1% is used.

Procedure:

a. Place CE-3 on its back, remove power-supply-regulator board (first board to the right of the VCO assembly.

b. Insert extender board between the board and the board receptacle.

c. Measure -12-volt supply voltage at pin 14 of CH-J3 (RF plug-in receptacle), orange wire. Reading should be exactly -12.0 volts. If not, adjust R25, the upper (large) potentiometer on the extended board.

d. Measure +20-volt supply voltage at pin 17 of CH-J3, red wire. Reading should be exactly +20.0 volts. If not, adjust R9, the lower (large) potentiometer on the extended board.

e. Measure the +5-volt supply voltage at pin 15 of CH-J3, green wire. Reading should be exactly +5.0 volts. If not, adjust R15, the center (small) potentiometer on the extended board.

5.2.2 Master Oscillator Frequency

Test Equipment Required (Method 1):

Sensitive receiver, equipped with signal strength meter and capable of receiving station WWV on 10 MHz.

Test Equipment Required (Method 2):

Frequency Counter with a crystal time-base-accuracy of at least 1 part in 10^7 (0.00001%).

Method 1:

For this method a 10-MHz signal from the CE-3 is compared with WWV on 10 MHz. In the CE-3 this signal is one of the inputs to the Signal Generator Mixer and its level is controlled by the front panel attenuators. To successfully use the WWV signal as a calibration standard, the following precautions should be taken:

1. Perform the calibration adjustments around mid-day, when the Doppler effect, that has some influence around sunrise and sunset, is minimal (WWV is currently located in Colorado).

2. Identify the stations as WWV by voice announcements.

3. Perform calibration adjustments when reception is as clear and as noise-free as possible (locations of receiver and antenna are also important).

4. CE-3 must have warmed up for at least 30 minutes before attempting adjustment

To verify Master-Oscillator Frequency:

a. Tune receiver to WWV.

b. Using function switch, select CW-signal generation. Turn 1st frequency selector to "1". A 10 MHz signal will be available at the cable that goes to the right-angle BNC connector on the Signal Generator Mixer (Figure 5-3).

c. Obtain a length of coaxial cable with a suitable BNC connector on one end; separated conductor and shield on the other.

d. Connect cable to the BNC connector mentioned in step b.

e. Note the reading of the receiver signal-strength meter.

f. Remove antenna from receiver and connect the insulated conductor of the coaxial cable to the receiver antenna terminals.

g. Advance the SIGNAL GEN/ATTEN. controls while watching the receiver signal-strength meter. Set the attenuator for the same signal strength noted in Step e.

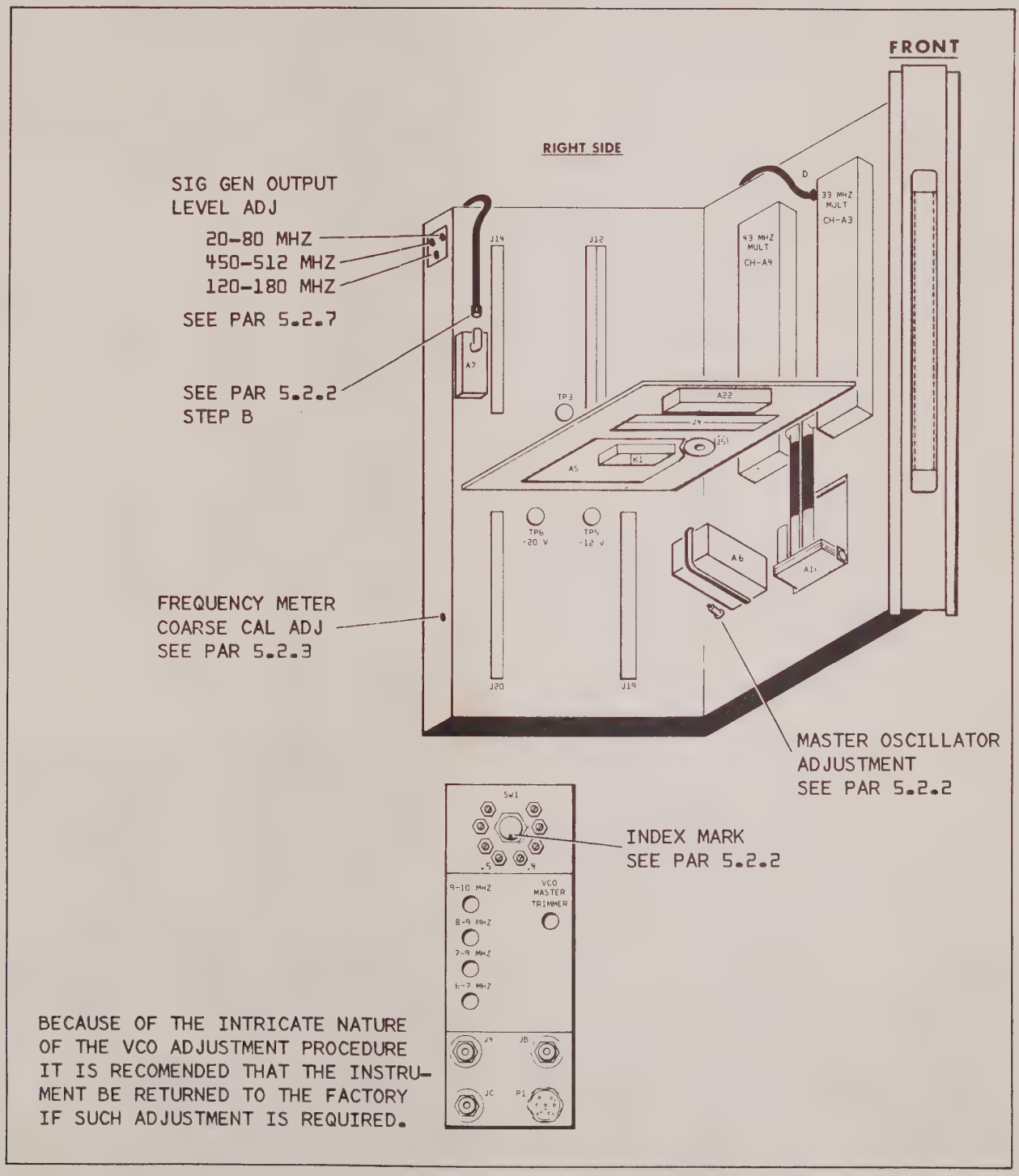


Figure 5-3. Location of Adjustment Points

h. Reconnect the antenna to the receiver, taking care that the coupling of the input from the CE-3 is not materially changed.

i. If the CE-3 is producing a signal with the same frequency as WWV, the meter needle will indicate almost no signal (null).

The two signals to the receiver are heterodyned and if they are of the same relative strength, the needle of the signal-strength meter may flutter but will essentially indicate "no signal". If the attenuator controls on the CE-3 are not correctly adjusted and the CE-3 signal is significantly stronger than the signal received from WWV, it will be impossible to obtain the "no-signal" indication. But, when the CE-3 attenuator has been properly adjusted and the "no-signal" indication can still not be obtained, the Master Oscillator is "off-frequency".

To adjust the Master Oscillator Frequency:

a. If step i of the above procedure does not result in a null, carefully remove the receiver antenna leaving the lead from the CE-3 connected. DO NOT detune the receiver.

b. Looking at the right side of the CE-3 - with the cover removed - a square "can" can be seen toward the rear of the instrument. (The can is kept in place with a spring that is partially covered with plastic tubing.) Below the can, the threaded shaft of the MO trimmer capacitor protrudes (Figure 5-3).

CAUTION

To reach the capacitor-adjusting shaft, a long-bladed, slotted, plastic screwdriver should be used. Do not insert hand; 115 vac is present on terminal strip and fuse holder.
The trimmer capacitor is of the glass-piston type, adjustment must be done very carefully.

c. Adjust MO trimmer capacitor to achieve maximum signal indication. If necessary, readjust the 10-MHz level for a reading on the signal-strength meter of the receiver as was noted in step e of the verification procedure.

d. Reconnect the antenna lead to the receiver. It should now be possible to achieve the "no signal" or null indication.

Method 2:

If no receiver capable of accurately indicating WWV signal-strength is available, a frequency counter may be used. This counter MUST be accurate to 1 part in 10 million.

a. Remove cable marked "D" from the input to the 330 MHz Harmonic Generator. (Looking at the right side of the CE-3 with the side cover removed and no accessory unit plugged in, it is the rectangular box directly below the carrying handle, Figure 5-3. The cable marked "D" is at the lower left corner of the box.

b. Obtain a length of RG 55/U coaxial cable with a phono (RCA) plug on one end and a connector that fits the frequency-counter input jack on the other. Connect this cable between cable marked "D" and the frequency counter. Turn 1st frequency selector to "1", counter should indicate 33.0 MHz. If the counter indicates an error of more than 10 Hz (10 Hz = 3 parts in 10 million at 33 MHz), the master oscillator requires adjustment.

c. Adjust the master-oscillator trimmer capacitor as described in step d of the Method 1 adjustment procedure, except that the counter is observed for the desired reading.

5.2.3 Discriminator Zero

a. Set function switch to CAL.

b. Mechanically center inner red control knob of the function switch.

c. Adjust FREQ. METER COARSE CAL. ADJUST for a zero reading on the FREQUENCY meter. The control is accessible from the right of the CE-3 (with the cover removed). Use the appropriate plastic tuning tool.

5.2.4 Modulator Center Frequency

a. With function switch in CAL, zero discriminator as described in 5.2.3.

b. Set function switch to FM.

c. Place the FM CAL control (red knob concentric with DEV. ADJ. control) in a 10 o'clock position (white line slightly above horizontal and pointing left).

d. Turn DEV. ADJ. control to fully counterclockwise position.

e. Place CE-3 on its back and remove bottom cover.

f. Extract 10-MHz Modulator board (Figure 5-1). Insert board extender between board and J14 and adjust the black coil in the middle of the board for a zero reading on the FREQUENCY meter.

5.2.5 FREQUENCY Meter Range

The IF output of the CE-3 can be used to calibrate the CE-3 FREQUENCY meter. This is sufficiently accurate if the Master oscillator has first been adjusted.

a. With the power to the CE-3 off, mechanically zero the meter needle. (Adjustment screw is reached through the small hole in the front panel directly below the meter.)

b. Reconnect power.

c. Set function switch to CAL.

d. Electrically zero the meter with the red knob that is concentric with the function switch.

e. Set function switch to FREQ.-DEV. MEASURE.

f. Dial-in "IF 09.999".

g. Connect a cable from the IF FREQUENCIES OUTPUT connector to the ANT. connector.

h. Turn the IF LEVEL control fully clockwise.

i. Set the meter range switch (lever switch) to ±1.5 kHz.

j. If the meter does not read minus (-) 1.0 kHz on the lower scale, adjust potentiometer R6 on the printed circuit board (FP-A1) mounted on the back of the FREQUENCY meter. R6, 1kΩ,is the upper (rectangular) potentiometer that can be seen through the opening in the front panel when the Deviation Meter or Oscilloscope is removed.

k. Set the meter range switch to ±5 kHz.

l. Dial-in "IF 09.995".

m. Meter should read minus (-) 5.0 kHz on the upper scale. If not, adjust potentiometer R4, 5KΩ, the middle (next to R6) potentiometer on the printed circuit board.

n. Set the meter range switch to ±15 kHz.

o. Dial-in "IF 09.985".

p. Meter should read minus (-) 15 kHz on the lower scale. If not, adjust potentiometer R2, 10KΩ, the lower potentiometer (next to R4) on the printed circuit board.

To verify if the meter needle deflects properly toward the positive side successively dial-in "IF 10.001", "IF 10.005", and "IF 10.015".

5.2.6 20-db Fixed Attenuator

The main reason for using the attenuator is to prevent damage to the CE-3 when the transmitter of a transceiver, to which the CE-3 is connected directly, is keyed accidentally. The attenuator incorporates two RF fuses (Bussman No. GFA 1/32A) which provide the protection. Depending on the power of the transmitter that is accidentally keyed, the fuses will blow or the resistors in the attenuator will experience momentary overload which can cause them to change value and thereby, change the attenuation.

If there is reason to suspect damage to the attenuator, verify its condition as follows:

a. Using an RF source calibrated in db and an RF voltmeter with a 50Ω input, measure the attenuation which should be 20 ±1/2 db.

b. If no RF voltmeter is available a metered receiver can be used as in the signal-generation adjustment procedure (5.2.7).

c. If the attenuation is not correct to within 1/2 db; measure the fuses and the resistors inside the attenuator. When repair is necessary, use only 5% resistors of the values indicated in Figure 6-17. The fuses are of a special, RF type; two spares are furnished with a new CE-3 and they may also be obtained from Cushman Electronics (Cushman Part No. 7040-0018) in packages of 10 fuses.

5.2.7 Signal-Generation Output Level

Test Equipment Required:

RF Signal Generator with a 50Ω input impedance (Hewlett-Packard Model 608 or equivalent).

Receiver capable of operating at the frequencies to be calibrated and with a signal-strength meter.

Calibration is performed by signal substitution into a metered receiver; an accurate external source is used first, which is then replaced by a signal generated in the CE-3. A receiver with a built-in signal-strength meter should be used. If such a receiver is not available, a receiver without a meter can be used in conjunction with a VTVM. The point at which the signal level should be metered should be chosen such that saturation is least likely to occur (for instance, at the first or second IF stage).

Procedure:

a. Dial-in the frequency at which adjustment is to be made and turn function switch to CW. Typical calibration frequencies are:

Frequency Range	Calibration Frequency
20 to 80 MHz	35 MHz
120 to 180 MHz	155 MHz
450 to 512 MHz	460 MHz

b. Adjust signal generator to the dialed-in frequency. To set signal-generator on frequency, connect the signal generator to the input of a Broadband Mixer or appropriate Preselector. Proceed as if monitoring a transmitter with the CE-3. At frequencies above 100 MHz, tune the signal generator slowly to accommodate the CE-3's narrow bandwidth.

c. Connect the signal-generator output to the receiver input through the 20-db fixed attenuator furnished with the CE-3.

d. Adjust the signal generator for a 1 μV output. The 20-db fixed attenuator will divide this by 10 and the input to the receiver should be 1 μV. Note the reading on the signal strength meter of the receiver. Ascertain that the meter reading does not indicate saturation.

e. Remove signal-generator connection to receiver and substitute CE-3 as signal source. Use the 20-db fixed attenuator.

f. Turn CE-3 function switch to CW.

g. Set SIGNAL GEN. ATTEN. to X1 and MICROVOLTS control to 1.0.

h. Note reading on receiver. This reading should be within ±2 db of the reading noted in step d.

If it is impossible to attain the same meter readings as described above, the CE-3 should be left connected to the receiver (via the 20-db attenuator) and the appropriate control on the modulator board should be adjusted. The controls are accessible from the right of the CE-3, Figure 5-3.

NOTE

It is recommended that the procedures described above be performed at all three calibration frequencies listed in step a.

After signal-generation adjustment in CW has been performed, FM signals (no modulation) generated by the CE-3 should be within 1 db of the levels noted for CW signals.

5.3 Troubleshooting

5.3.1 General Information

In all modes of operation, except when generating IF frequencies, the phase-locked loop consisting of the frequency-synthesizing elements is the "heart" of the CE-3. When the loop is not phase-locked, the proper frequencies are not synthesized. The UNLOCKED indicator on the front panel gives an accurate indication of this condition.

The UNLOCKED indicator is out when the two 100-kHz signals to the Phase Detector (p/o CH-A9, board 0047) are phase-locked or, when both signals are absent.

When the UNLOCKED indicator is on there has been a malfunction and the area in which this malfunction has occurred can be determined (WITH THE POWER OFF) by removing the Sample-and-Hold board (CH-A10, board 0046).

If the trouble is in the Crystal Oven (CH-A6); the Master Oscillator (CH-A17, board 0061); or the Reference Divider/ Phase Detector (CH-A9, board 0047), the UNLOCKED indicator will go out.

If, with the Sample-and-Hold board removed the UNLOCKED indicator is still on, the trouble is probably in the loop itself, that is, in the Sample-and-Hold circuits, (CH-A10, board 0046); the Reference Divider/Phase Detector (CH-A9, board 0047); the Divide-by-N Counter (CH-A12, board 0069); or, the VCO Assembly (CH-A21, board 0045).

To further narrow down the area in which the trouble lies, signal tracing with a high-frequency oscilloscope (HP 180 or equivalent) or Frequency Counter (HP 5240 or equivalent) is recommended. Figure 5-2 is a troubleshooting block diagram which shows the signal frequencies that should be present and where the signals should be sampled.

If the required test equipment is not available, boards to which the trouble has been tentatively traced may be sent for repair to Cushman Electronics, Customer-Service Department, 166 San Lazaro, Sunnyvale, California, 94086.

Especially when it is suspected that the Divide-by-N board is defective, this procedure is recommended.

It is assumed that, when a malfunction is suspected, an attempt will first be made to perform the various adjustment procedures given in the Maintenance part of this section. The inability to perform the adjustments successfully can, in itself, serve to localize the source of trouble.

If, for instance, signal substitution fails to produce equal reading on a metered receiver (5.2.7), when operating the CE-3 in the FM-signal-generation mode, but does produce equal readings when operated in the CW-generation mode; it is virtually certain that a malfunction occurred in the 10-MHz Modulator (CH-A14, board 0062). Conversely, if it is possible to get equal readings in the FM mode but not in the CW mode; trouble must be suspected in the Master Oscillator (CH-A17, board 0061) or the Crystal Oven (CH-A6).

If, after removing and replacing the VCO assembly, the UNLOCKED indicator remains on, the absence of a phase-locked condition is probably due to misalignment of the VCO switch with the third frequency selector. (Verification of alignment is discussed in 5.1.3; see Figure 5-3.)

5.3.2 Use of the Troubleshooting Table

When a malfunction develops, there is usually some external evidence, such as the failure of a meter to indicate or a lamp to light, or a lack of signal output. These indications are listed in the left-hand column of Table 5-2. The circuit or point to be checked is listed in the second column and; the probable cause in the third and the reference to be consulted in order to rectify the problem is given in the last column.

NOTES

1. If more than one CE-3 is available, board substitution is the quickest way to localize the problem.

2. When a connection is broken to measure the signal level, the instrument used to measure must have an input impedance of 50Ω.

3. If measurement is made without breaking a connection, a high impedance probe must be used.

4. When troubleshooting, frequent reference to Figure 5-2 will aid in understanding how the various internal signals are developed.

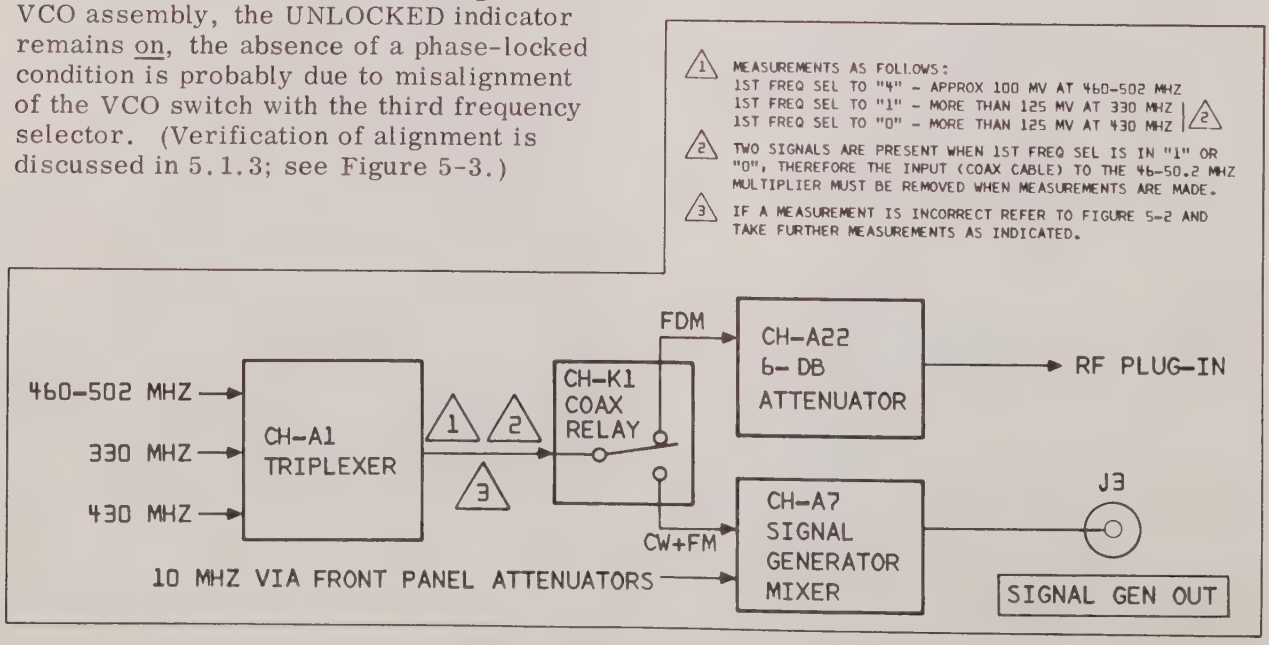

1 MEASUREMENTS AS FOLLOWS:
1ST FREQ SEL TO "4" - APPROX 100 MV AT 460-502 MHZ
1ST FREQ SEL TO "1" - MORE THAN 125 MV AT 330 MHZ
1ST FREQ SEL TO "0" - MORE THAN 125 MV AT 430 MHZ
2
2 TWO SIGNALS ARE PRESENT WHEN 1ST FREQ SEL IS IN "1" OR "0", THEREFORE THE INPUT (COAX CABLE) TO THE 46-50.2 MHZ MULTIPLIER MUST BE REMOVED WHEN MEASUREMENTS ARE MADE.
3 IF A MEASUREMENT IS INCORRECT REFER TO FIGURE 5-2 AND TAKE FURTHER MEASUREMENTS AS INDICATED.
460-502 MHZ
330 MHZ
430 MHZ
CH-A1 TRIPLEXER
1
2
3
CH-K1 COAX RELAY
FDM
CH-A22 6-DB ATTENUATOR
RF PLUG-IN
CW+FM
CH-A7 SIGNAL GENERATOR MIXER
J3
SIGNAL GEN OUT
10 MHZ VIA FRONT PANEL ATTENUATORS

Figure 5-4. LO Signal Flow

Table 5-2. Troubleshooting

TROUBLE	CHECK	PROBABLE CAUSE	REFERENCE
1. Meters inoperative	Remote Meter switch	Remote Meter switch in EXT. position	Rear Panel
2. CE-3 inoperative except for	+20 and +5V DC	Power Supply Regulator fuses	Table 5-1, Fig. 6-18
3. FREQUENCY meter pinned, SIGNAL LEVEL indicator on, UNLOCKED indicator on.	-12V DC	Power Supply Regulator fuses	Table 5-1, Fig. 6-18
4. No RF-signal reception, signal generation OK.	a. Coaxial Relay b. RF Plug-in	a. Coaxial Relay b. Mixer diode or IF strip	a. CH-K1, Fig. 5-3 b. Appropriate plug-in manual
5. No signal generation, reception OK, calibration (CAL) OK.	a. Coaxial Relay b. Sig. Gen. Mixer c. 20-db Fixed Atten.	a. Coaxial Relay b. Defective diode c. RF fuses	a. CH-K1, Fig. 5-3 b. 50Ω FWD, 200KΩ REVERSE c. Para. 5.2.6
6. No signal generation, no calibration in FM or CW. possible, reception OK.	10-MHz Modulator	10-MHz Modulator	Fig. 6-16
7. No reception, no signal generation, calibration OK.	Path of LO signal		Fig. 5-4
8. No CW-signal generation, FM-signal generation OK.	300 mv at pin 14 of J14 a. signal OK b. no signal	 a. 10-MHz Modulator b. Master Oscillator	Fig. 5-3 a. Fig. 6-16 b. Fig. 6-1
9. No FM signal generation CW signal generation OK.	10-MHz Modulator	10-MHz Modulator	Fig. 6-16
10. No calibration, no signal generation, UNLOCKED light on	3 MHz at pin 4 of J17 a. signal OK b. no signal	 a. Master Oscillator b. Master Oscillator or Crystal oven	Fig. 5-3 a. Fig. 6-1 b. Fig. 6-1 and Fig. 5-3
11. FREQUENCY meter pinned in CAL or CW, SIGNAL LEVEL indicator on	100 MV of 9.9 MHz at pin 21 of J20 a. signal OK b. if no signal check: 100 kHz pulse at pin 21 of J8 a. signal OK b. no signal	 a. Second IF and Discriminator a. 1-4 MHz Mixer and 9.9 MHz Filter b. Reference Divider and Phase Detector	Fig. 5-3 a. Fig. 6-14 b. Fig. 5-3 a. Fig. 6-13 b. Fig. 6-2
12. SIGNAL LEVEL indicator on, FREQUENCY meter pinned in FDM.	RF plug-in	Squelch misadjusted	See appropriate plug-in manual
13. UNLOCKED indicator blinks slowly (about once per second)	Sample and Hold	Sample and Hold	Fig. 6-5
14. UNLOCKED indicator on but CE-3 appears to function OK.	Reference Divider and Phase Detector	Reference Divider and Phase Detector	Fig. 6-2
15. UNLOCKED indicator on in some positions of third frequency selector	Index mark on VCO shaft	Mechanical misalignment	See Para. 5.13 and Fig. 5-3
16. UNLOCKED indicator on in some combinations of frequency-selectors positions but not of others.	Divide-by-N Counter	Divide-by-N Counter	Fig. 6-4
17. UNLOCKED indicator on in all combinations of frequency-selector positions.	Frequency synthesizer loop	Out of phase lock	See Para. 5.3.1

SECTION 6
SCHEMATICS, PARTS LISTS, AND PARTS PICTORIALS

6.1 Reference Designators

A	assembly
B	board
C	capacitor
CR	diode
DS	device signaling (lamp
E	misc. electronic part
F	fuse
FIL	filter
J	jack
K	relay
L	inductor, RF, choke
M	meter
CH	chassis
FP	front panel
RP	rear panel
P	plug
Q	transistor
R	resistor
RT	thermistor
SW	switch
T	transformer
TB	terminal board
TP	test point
V	vacuum and display tubes
X	crystal
SCR	silicon controlled rectifier
LS	speaker

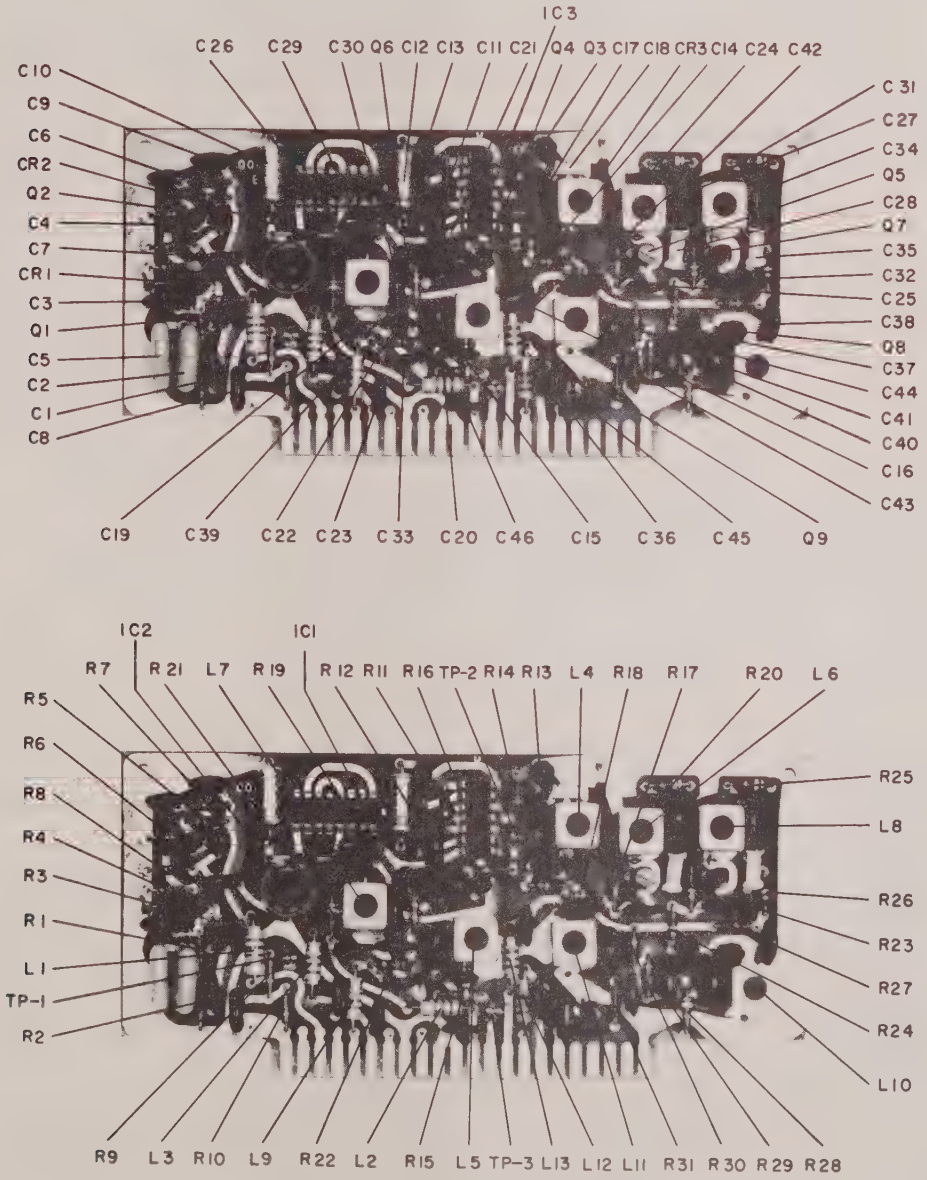
6.2 Abbreviations

Amp	amperes
AFC	Automatic frequency control
Ampl	amplifier
BP	bandpass
CCW	counter-clockwise
Cer	ceramic
Coef	coefficient
Com	common
Comp	composition
Conn	connector
CRT	cathode-ray tube
CW	clockwise
DepC	deposited carbon
Electro	electrolytic
Encap	encapsulated
EXT	external
F	farads
Ge	germanium
GRD	ground(ed)
H	Henries
Hz or HZ	hertz
IF	intermediate frequency
Incd	incandescent
INT	internal
k	kilo - 10^3
Lin	linear
Log	logarithmic
LPF	low pass filter
m	milli - 10^{-3}
M	meg - 10^{-6}
MF	microfarad
MFLM	metal film
MFR	manufacturer
Minat	miniature
Mom	momentary
My	"mylar"
N	nano 10^{-9}
NC	not connected
N/C	normally closed
N/O	normally open
NPO	negative positive zero
NRFR	not recommended for field replacement
P	peak
PC	printed circuit
pF or PF	picofarads - 10^{-12} farads
PIV	peak inverse voltage
P/O	part of
Poly	polystyrene or polyester
Porc	porcelain
Pos	position(s)
Pot	potentiometer
P/P	peak-to-peak
Rect	rectifier
RF	radio frequency
S-B	slow-blow
Semi	semiconductor
Si	silicon
Ta	tantalum
Tog	toggle
Tol	tolerance
Trim	trimmer
TYP	typical
μ	micro - 10^{-6}
V	volts
Var	variable
VDCW	dc working volts
W/	with
W	watts
ww	wirewound
W/O	without

6.3 Schematics, Parts Lists, and Parts Pictorials

Parts 6.3.1 through 6.3.19, on the following pages, provide schematics, parts lists, and parts pictorials for the various subassemblies described in Section 4. The parts are arranged in the order in which they appear in that section and, with three exceptions, each part consists of a parts list, one or more parts pictorials and a schematic. The exceptions are parts 6.3.11, 6.3.15, and 6.3.19 which deal with combinations of subassemblies that are shown on one schematic. Where necessary, separate parts lists and parts pictorials have been provided.

6.3.1 Master Oscillator, Divider and Filters, CH-A17



6.3.1 MASTER OSCILLATOR, DIVIDER AND FILTERS, CH-A17

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A17	Master Oscillator Board Assy	7000-0061	Cushman
	Master Oscillator Board, Bare	1780-0061	Cushman
	CAPACITORS		
C1	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C2	Poly, 0.0012 MF ± 10%, 100V	1008-0016	Sprague
C3	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C4	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C5	Poly, 0.0027 MF ±10%, 100V	1008-0009	Sprague
C6	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C7	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C8	Mica, 180 pF ±5%, 100V	1002-0005	Elmenco
C9	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C10	Elect., 15 MF, 12V	1013-0015	Sprague
C11	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C12	Elect., 15 MF, 12V	1013-0015	Sprague
C13	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C14	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C15	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C16	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C17	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C18	Cer, 8.2 pF ±0.25 pF, 250V	1005-0043	Erie
C19	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C20	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C21	Mica, 10 pF ±5%, 100V	1002-0016	Elmenco
C22	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C23	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C24	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C25	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C26	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C27	Mica, 390pF ±5%, 100V	1002-0033	Elmenco
C28	Cer, 8.2 pF ±0.25 pF, 250V	1005-0043	Erie
C29	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C30	Mica, 27 pF ±5%, 100V	1002-0008	Elmenco
C31	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C32	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C33	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C34	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C35	Cer, 8.2 pF ±0.25 pF, 250V	1005-0043	Erie

6.3.1 MASTER OSCILLATOR, DIVIDER AND FILTERS, CH-A17 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C36	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C37	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C38	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C39	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C40	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C41	Mica, 10 pF ±5%, 100V	1002-0016	Elmenco
C42	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C43	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C44	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C45	Mica, 10 pF ±5%, 100V	1002-0016	Elmenco
C46	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
	COILS		
L1	RF Choke, 680 µH ±5%	1585-0023	Delevan
L2	RF Choke, 220 µH ±5%	1585-0018	Delevan
L3	RF Choke, 220 µH ±5%	1585-0018	Delevan
L4	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L5	Var Inductor, 0.50-0.75 µH	1596-0011	TRW
L6	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L7	Var Inductor, 0.50-0.75 µH	1596-0011	TRW
L8	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L9	RF Choke, 220 µH ±5%	1585-0018	Delevan
L10	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L11	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L12	RF Choke, 220 µH ±5%	1585-0018	Delevan
L13	RF Choke, 220 µH ±5%	1585-0018	Delevan
	DIODES		
CR1	Si, Zener 6.8V, 1N957	1281-0007	Motorola
CR2	Si, 1N4002	1281-0023	Sylvania
CR3	Si, 1N3064	1281-0013	Transitron
	INTEGRATED CIRCUITS		
IC1	TTL Dual Flip-Flop, SN7476N	2025-0005	T.I.
IC2	RTL Buffer, U8A-9900-28X	2025-0011	Fairchild
IC3	TTL NAND Gates, SN7400	2025-0003	T.I.
	RESISTORS		
R1	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R2	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R3	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley

6.3.1 MASTER OSCILLATOR, DIVIDER AND FILTERS, CH-A17 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R5	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R6	Comp, 27kΩ ±5%, 1/4W	1066-2735	Allen-Bradley
R7	Comp, 680Ω ±5%, 1/4W	1066-6815	Allen-Bradley
R8	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R9	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R10	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R11	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R12	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R14	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R15	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R16	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R17	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R18	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R19	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R20	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R21	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R22	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R23	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R24	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R25	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R26	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R27	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R28	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R29	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R30	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R31	Comp, 1kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, PNP, 2N4121	1272-0023	Fairchild
Q3	Si, NPN, 2N3563	1272-0022	Fairchild
Q4	Si, NPN, 2N3563	1272-0022	Fairchild
Q5	Si, PNP, TIS37	1271-0003	T.I.
Q6	Si, NPN, 2N3563	1272-0022	Fairchild
Q7	Si, PNP, TIS37	1271-0003	T.I.
Q8	Si, PNP, TIS37	1271-0003	T.I.
Q9	Si, PNP, TIS37	1271-0003	T.I.

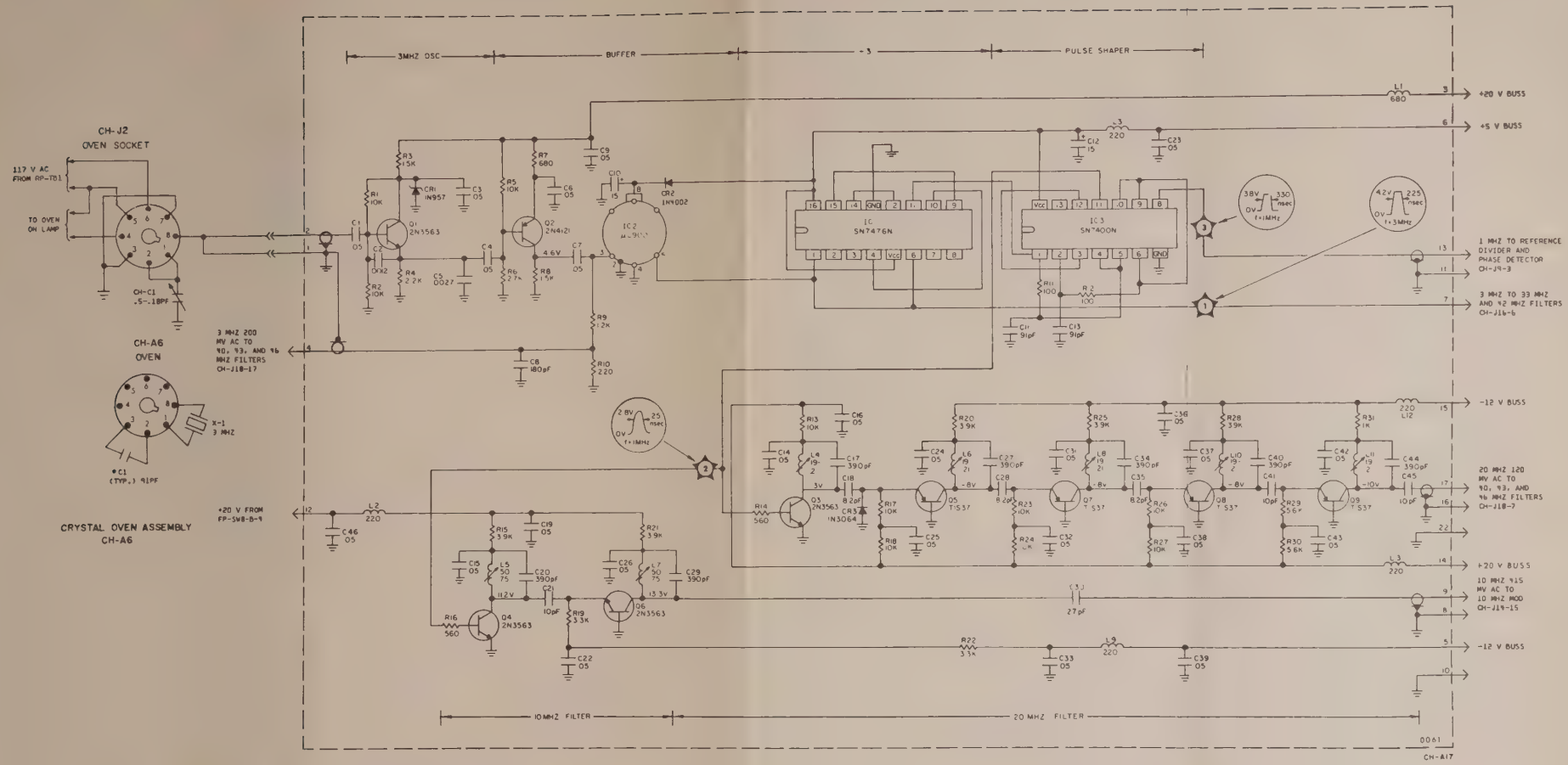
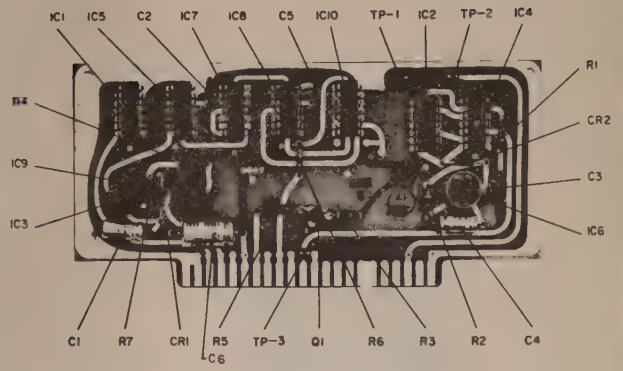


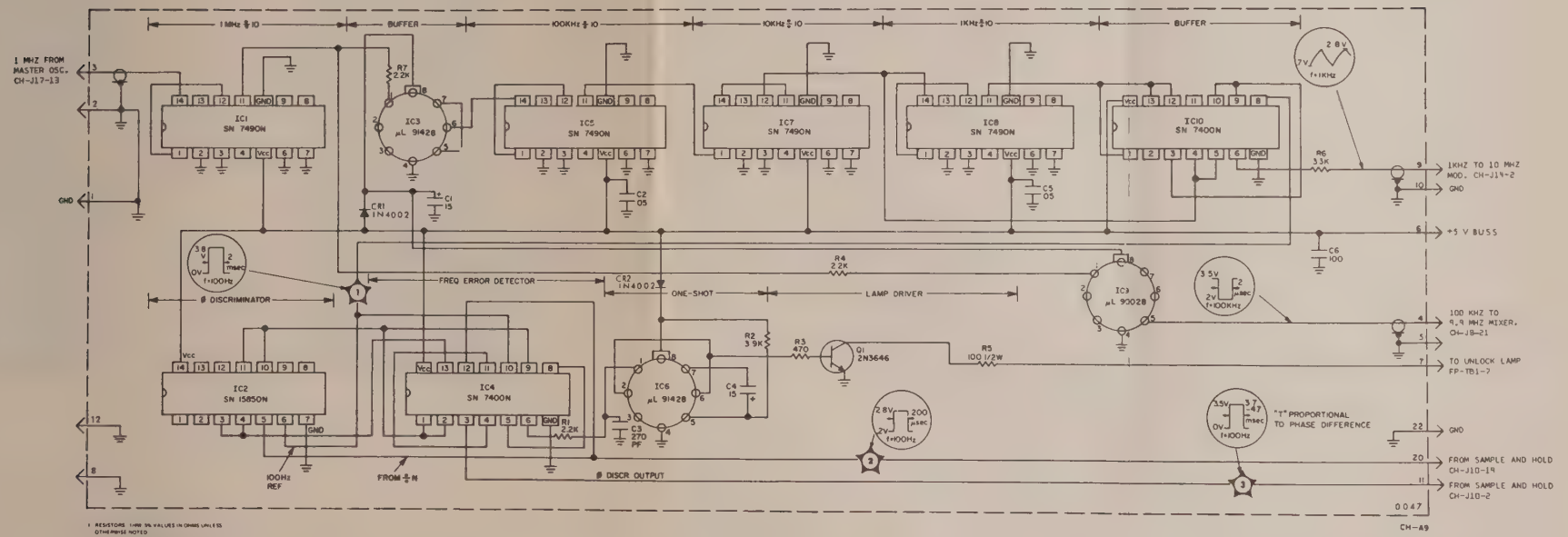
Figure 6-1. Master Oscillator, Divider, and Filters (CH-A17, 0061)

6.3.2 Reference Divider and Phase Detector, CH-A9



6.3.2 REFERENCE DIVIDER AND PHASE DETECTOR, CH-A9

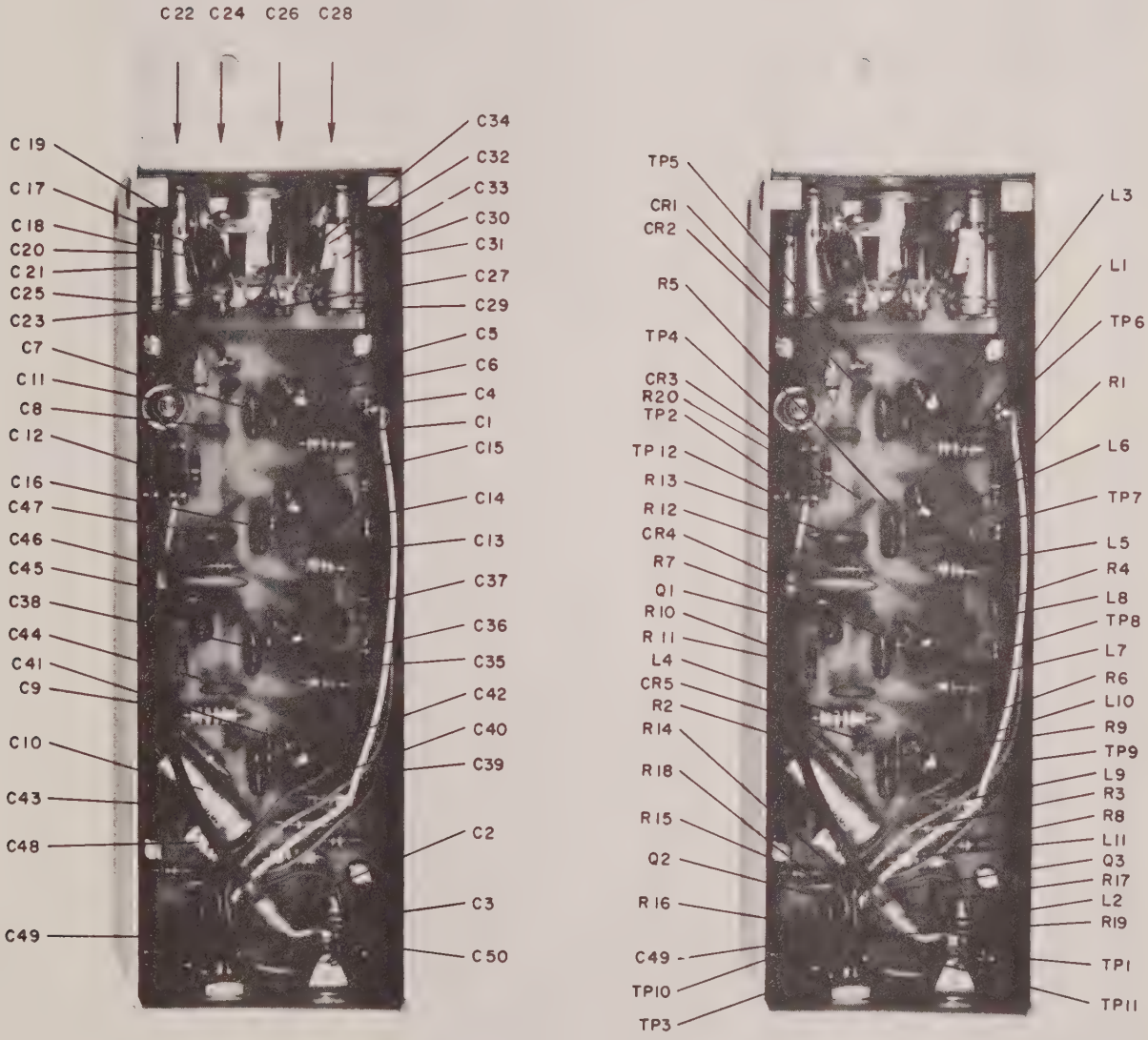
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A9	Reference Divider and Phase Detector Board Assy	7000-0047	Cushman
	Reference Divider Board, Bare	1780-0047	Cushman
	CAPACITORS		
C1	Elect., 15 MF, 12V	1013-0015	Sprague
C2	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C3	Mica, 270 pF ±5%, 100V	1002-0031	Elmenco
C4	Elect., 15 MF, 12V	1013-0015	Sprague
C5	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C6	Elect., 100 MF, 12V	1013-0015	Sprague
	DIODES		
CR1	Si, 1N4002	1281-0023	Diodes Inc
CR2	Si, 1N4002	1281-0023	Diodes Inc
	INTEGRATED CIRCUITS		
IC1	TTL Decade Counter, SN7490N	2025-0002	T.I
IC2	DTL Flip-Flop, SN15850N	2025-0009	T.I
IC3	RTL NOR Gates, U8A-9914-28X	2025-0010	Fairchild
IC4	TTL NAND Gates, SN7400N	2025-0003	T.I.
IC5	TTL Decade Counter, SN7490N	2025-0002	T.I
IC6	RTL NOR Gates, U8A-9914-28X	2025-0010	Fairchild
IC7	TTL Decade Counter, SN7490N	2025-0002	T.I.
IC8	TTL Decade Counter, SN7490N	2025-0002	T.I
IC9	RTL Buffer, U8A-9900-28X	2025-0011	Fairchild
IC10	TTL NAND Gates, SN7400N	2025-0003	T.I
	RESISTORS		
R1	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R2	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R3	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R5	Comp, 100Ω ±5%, 1/2W	1067-1015	Allen-Bradley
R6	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R7	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N4275	1272-0016	Fairchild



1. RESISTORS 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS VALUES IN µf UNLESS OTHERWISE NOTED
3. INDUCTORS VALUES IN µh UNLESS OTHERWISE NOTED
4. * - FACTORY SELECTED VALUE
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-2. Reference Divider and Phase Detector (CH-A9, 0047)

6.3.3 Voltage Controlled Oscillator, CH-A21



6.3.3 VOLTAGE CONTROLLED OSCILLATOR, CH-A21

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	VCO Assembly	7046-0004	Cushman
	CAPACITORS		
C17	Mica, 68 pF, ±1%, 100V	1002-0084	Elmenco
C18	Mica, 51 pF, ±5%, 100V	1002-0045	Elmenco
C19	Var, glass, 1-19 pF	1001-0001	JFD
C20	Mica, 43 pF, ±5%, 100V	1002-0046	Elmenco
C21	Var, glass, 1-18 pF	1001-0001	JFD
C22	Mica, 36 pF, ±5%, 100V	1002-0041	Elmenco
C23	Var, glass, 1-18 pF	1001-0001	JFD
C24	Mica, 30 pF, ±5%, 100V	1002-0043	Elmenco
C25	Var, glass 1-18 pF	1001-0001	JFD
C26	Mica, 22 pF, ±5%, 100V	1002-0023	Elmenco
C27	Var, glass, 1-18 pF	1001-0001	JFD
C28	Mica, 15 pF, ±5%, 100V	1002-0001	Elmenco
C29	Var, glass, 1-18 pF	1001-0001	JFD
C30	Mica, 10 pF, ±5%, 100V	1002-0016	Elmenco
C31	Var, glass, 1-18 pF	1001-0001	JFD
C32	Cer, 4.7 pF ±0.25 pF, 250V	1005-0015	Erie
C33	Var, glass, 1-18 pF	1001-0001	JFD
C34	Mica, 10 pF, ±5%, 100V	1002-0016	Elmenco
	CONNECTORS		
JA	Phono Jack, female	2586-0003	Switchcraft
JB	Phono Jack, female	2568-0003	Switchcraft
JC	Phono Jack, female	2568-0003	Switchcraft
P1	Plug, female, 7 pin	2535-0007	Amphenol
	SWITCHES		
SW1	Rotary, IP, 10 position	1851-0023	OAK
CH-A21	VCO Board Assembly	7000-0045	Cushman
	VCO Board, Bare	1780-0045	Cushman
	CAPACITORS		
C1	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C2	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C3	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C4	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
*C5	Mica, 27 pF ±5%, 100V	1002-0008	Elmenco

*Value is factory selected; a typical value is listed.

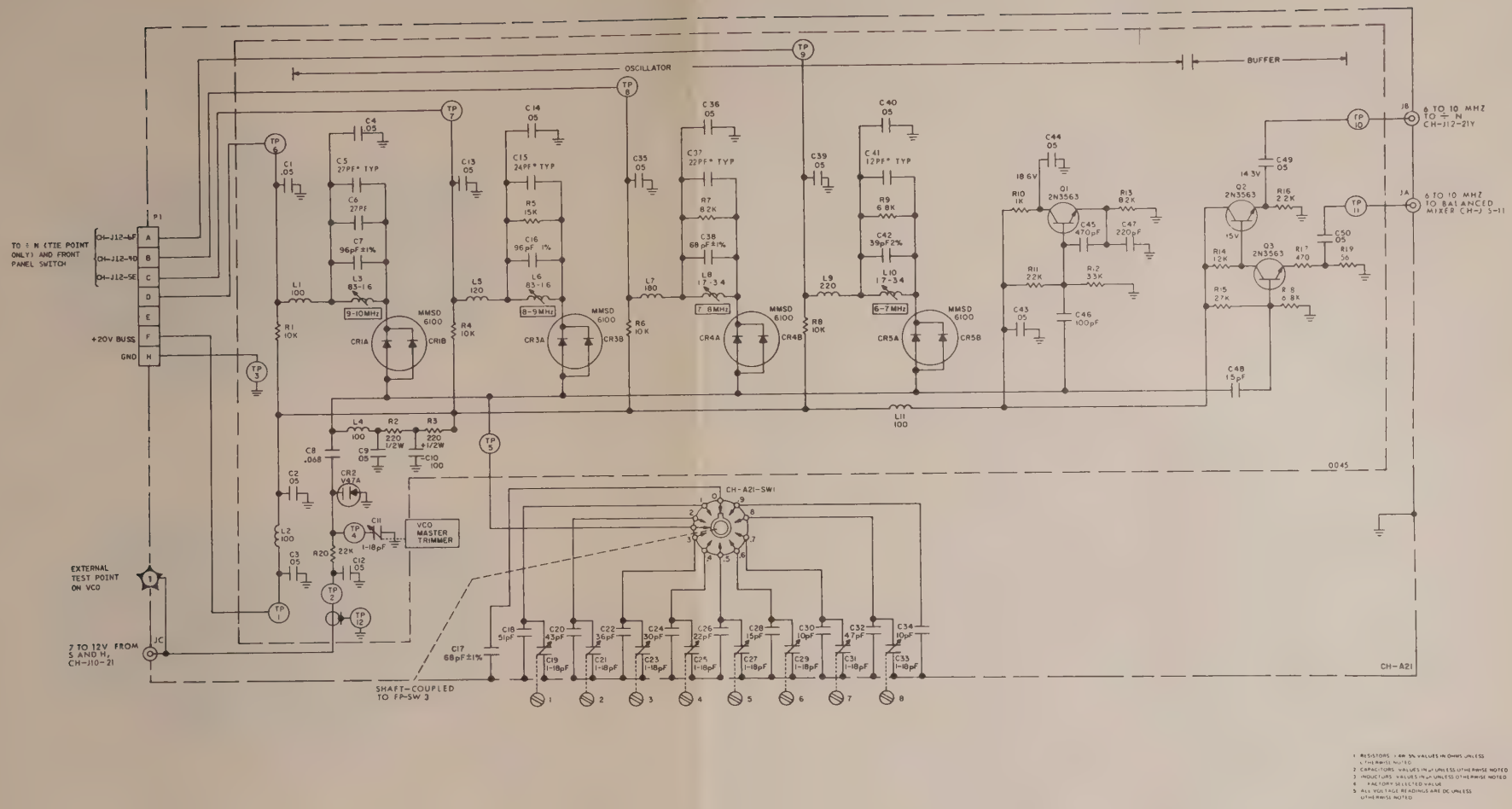
6.3.3 VOLTAGE CONTROLLED OSCILLATOR, CH-A21 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
L10	Var, 1.7-3.4 μH	1596-0019	Delevan
L11	RF Choke, 100 μH ±5%	1585-0017	Delevan
	DIODES		
CR1	Dual Si MMSD6100	1283-0002	Motorola
CR2	Voltage Var, C Diode V47A	1281-0019	TRW
CR3	Dual Si MMSD6100	1283-0002	Motorola
CR4	Dual Si MMSD6100	1283-0002	Motorola
CR5	Dual Si MMSD6100	1283-0002	Motorola
	RESISTORS		
R1	Comp, 1kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R2	Comp, 220Ω ±5%, 1/2W	1067-2215	Allen-Bradley
R3	Comp, 220Ω ±5%, 1/2W	1067-2215	Allen-Bradley
R4	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R5	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley
R6	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R7	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R8	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R9	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R10	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R11	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R12	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R13	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R14	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R15	Comp, 27kΩ ±5%, 1/4W	1066-2735	Allen-Bradley
R16	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R17	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R18	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R19	Comp, 56Ω ±5%, 1/4W	1066-5605	Allen-Bradley
R20	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, NPN, 2N3563	1272-0022	Fairchild
Q3	Si, NPN, 2N3563	1272-0022	Fairchild

6.3.3 VOLTAGE CONTROLLED OSCILLATOR, CH-A21 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C6	Mica, 39 pF ±2%, 100V	1002-0054	Elmenco
C7	Mica, 96 pF ±1%, 100V	1002-0049	Elmenco
*C8	Mylar, 0.068 ±10%, 100V	1008-0036	Sprague
C9	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C10	Elect., 100 MF, 25V	1013-0003	Sprague
C11	Var, glass, 1-18 pF	1001-0001	JFD
C12	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C13	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C14	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
*C15	Mica, 24 pF ±5%, 100V	1002-0051	Elmenco
C16	Mica, 96 pF ±1%, 100V	1002-0049	Elmenco
C17 through C34	part of VCO assembly		
C35	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C36	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
*C37	Mica, 22 pF ±5%, 100V	1002-0023	Elmenco
C38	Mica, 68 pF ±1%, 100V	1002-0084	Elmenco
C39	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C40	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
*C41	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C42	Mica, 39 pF ±2%, 100V	1002-0054	Elmenco
C43	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C44	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C45	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C46	Cer, 100 pF ±5%, 1000V	1005-0046	Sprague
C47	Mica, 220 pF ±5%, 100V	1002-0029	Elmenco
C48	Cer, 1.5 pF ±0.25 pF, 250V	1005-0041	Erie
C49	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C50	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
	COILS		
L1	RF Choke, 100 μH ±5%	1585-0017	Delevan
L2	RF Choke, 100 μH ±5%	1585-0017	Delevan
L3	Var, 0.83-1.6 μH	1596-0018	Delevan
L4	RF Choke, 100 μH ±5%	1585-0017	Delevan
L5	RF Choke, 120 μH ±5%	1585-0033	Delevan
L6	Var, 0.83-1.6 μH	1596-0018	Delevan
L7	RF Choke, 180 μH ±5%	1585-0035	Delevan
L8	Var, 1.7-3.4 μH	1596-0019	Delevan
L9	RF Choke, 220 μH ±5%	1585-0018	Delevan

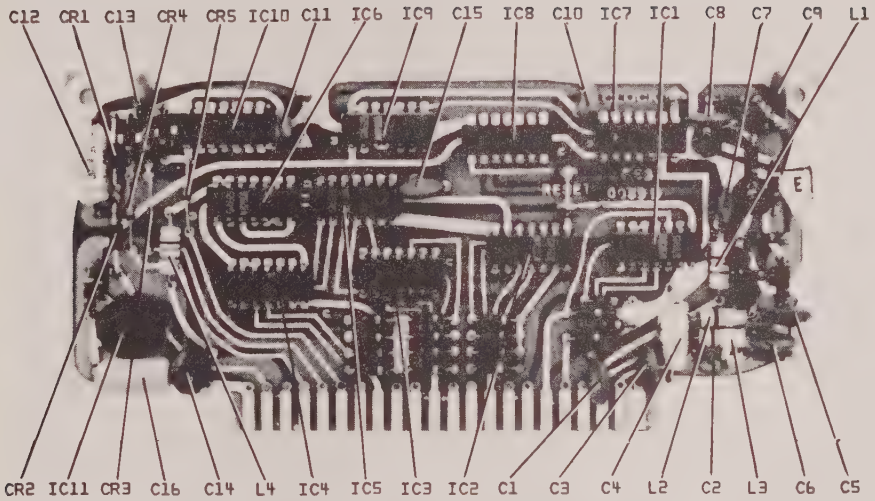
*Value is factory selected; a typical value is listed.

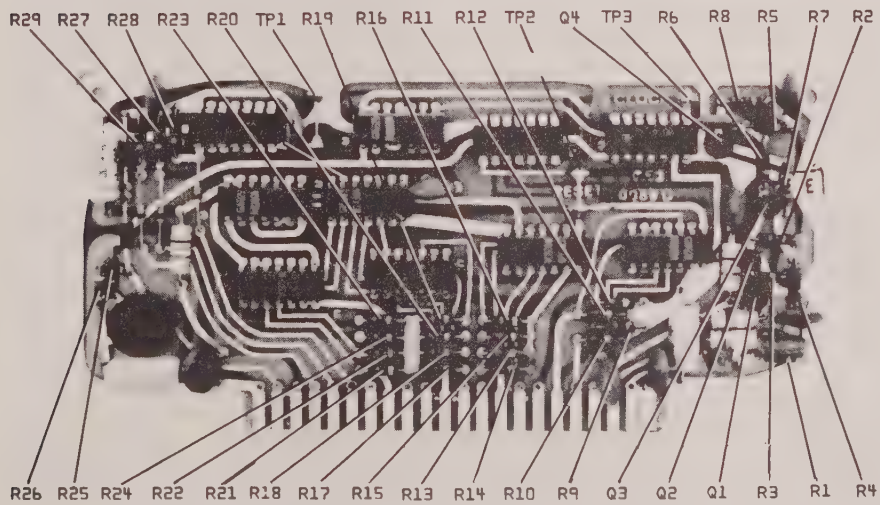


1. RESISTORS : OHMS 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS: VALUES IN μF UNLESS OTHERWISE NOTED
3. INDUCTORS: VALUES IN μH UNLESS OTHERWISE NOTED
4. FACTORY SELECTED VALUE
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-3. Voltage-Controlled Oscillator (CH-A21, 0045)

6.3.4 Divide-by-N Counter, CH-A12





6.3.4 DIVIDE-BY-N COUNTER, CH-A12

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A12	Divide-by-N Counter Board Assy	7000-0089	Cushman
	Divide-by-N Board, Bare	1780-0089	Cushman
	CAPACITORS		
C1	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C2	Disc, Cer, 0.01 MF +80% -20%, 100V	1005-0013	Erie
C3	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C4	Electrolytic, 15 MF, 12V	1013-0015	Sprague
C5	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C6	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C7	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C8	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C9	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C10	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C11	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C12	Electrolytic, 15 MF, 12V	1013-0015	Sprague
C13	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C14	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C15	Disc, Cer, 0.05 MF +80% -20%, 25V	1005-0015	Erie
C16	Mylar, 0.1 MF, 100V, 10%	1008-0031	Sprague
	COILS		
L1	RF Choke, 12 μH, 10%	1585-0011	Delevan
L2	RF Choke, 47 μH, 5%	1585-0010	Delevan
L3	RF Choke, 47 μH, 5%	1585-0010	Delevan
L4	RF Choke, 12 μH, 10%	1585-0011	Delevan
	DIODES		
CR1	Si, 1N4002	1281-0023	Diodes Inc.
CR2	Si, 1N4002	1281-0023	Diodes Inc.
CR3	Si, 1N3064	1281-0013	Diodes Inc.
CR4	Si, 1N3064	1281-0013	Diodes Inc.
CR5	Si, 1N3064	1281-0013	Diodes Inc.
	INTEGRATED CIRCUITS		
IC1	DCL Presettable Decade N8280A	2025-0016	Signetics
IC2	DCL Presettable Decade N8280A	2025-0016	Signetics
IC3	DCL Presettable Decade N8280A	2025-0016	Signetics
IC4	DCL Presettable Decade N8280A	2025-0016	Signetics

6.3.4 DIVIDE-BY-N COUNTER, CH-A12 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	TRANSISTORS		
Q1	Si, 2N3563	1272-0022	Fairchild
Q2	Si, 2N3563	1272-0022	Fairchild
Q3	Si, 2N4121	1272-0023	Fairchild
Q4	Si, 2N4275	1272-0016	Fairchild

6.3.4 DIVIDE-BY-N COUNTER, CH-A12 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
IC5	TTL NAND Gate N7430A	2025-0004	Signetics
IC6	DCL N8280A	2025-0016	Signetics
IC7	TTL AND Gate SN74M11	2025-0017	T.I.
IC8	TTL Dual Flip-Flop SN7472	2025-0007	T.I.
IC9	DCL N8280A	2025-0016	Signetics
IC10	TTL NAND Gate SN7400	2025-0003	T.I.
IC11	RTL NOR Gates U8A-9914-28X	2025-0010	Fairchild
	RESISTORS		
R1	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R2	Comp, 360Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R3	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R4	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R5	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R6	Comp, 120Ω ±5%, 1/4W	1066-1205	Allen-Bradley
R7	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R8	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R9	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R10	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R11	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R12	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R13	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R14	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R15	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R16	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R17	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R18	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R19	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R20	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R21	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R22	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R23	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R24	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R25	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R26	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R27	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R28	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R29	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley

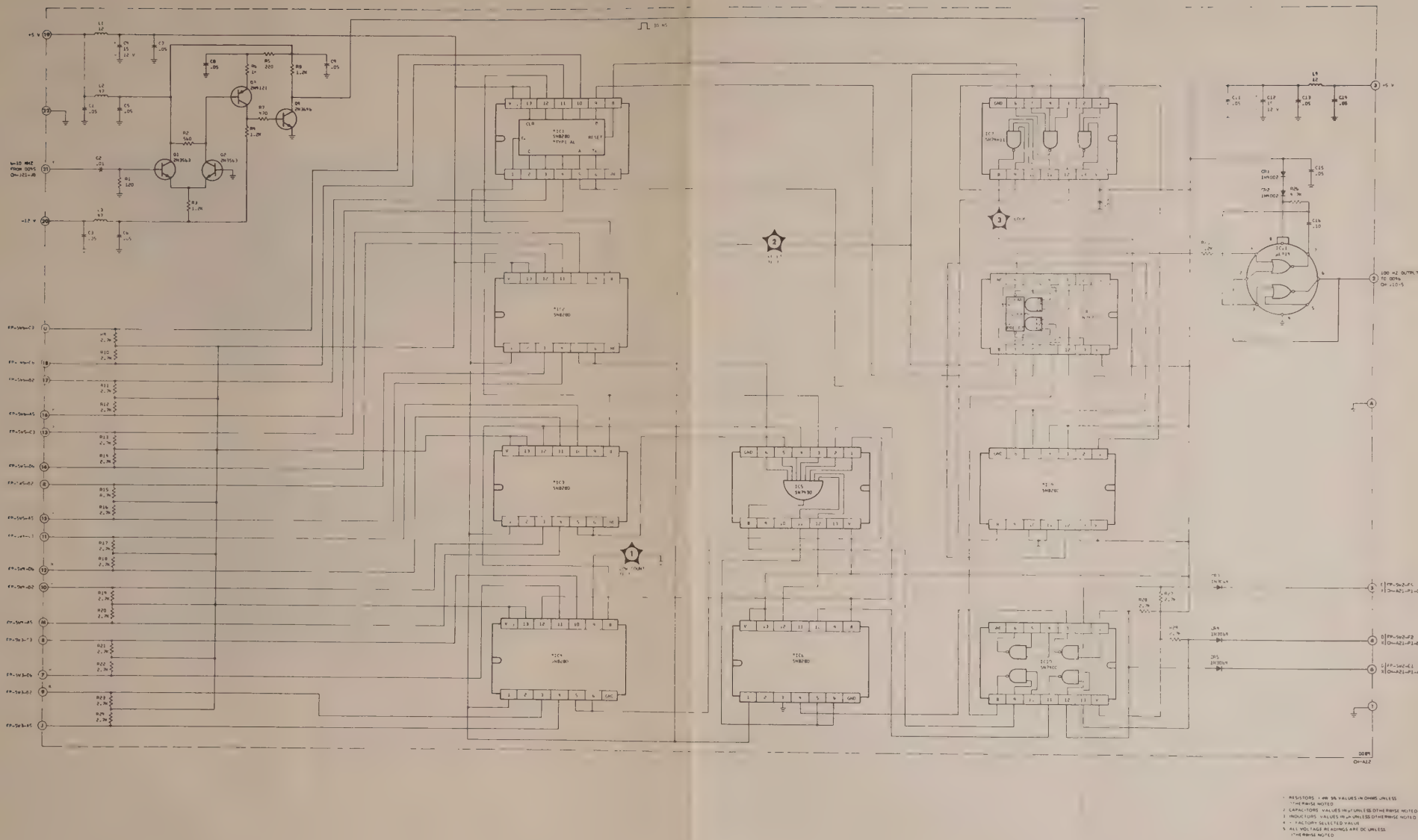
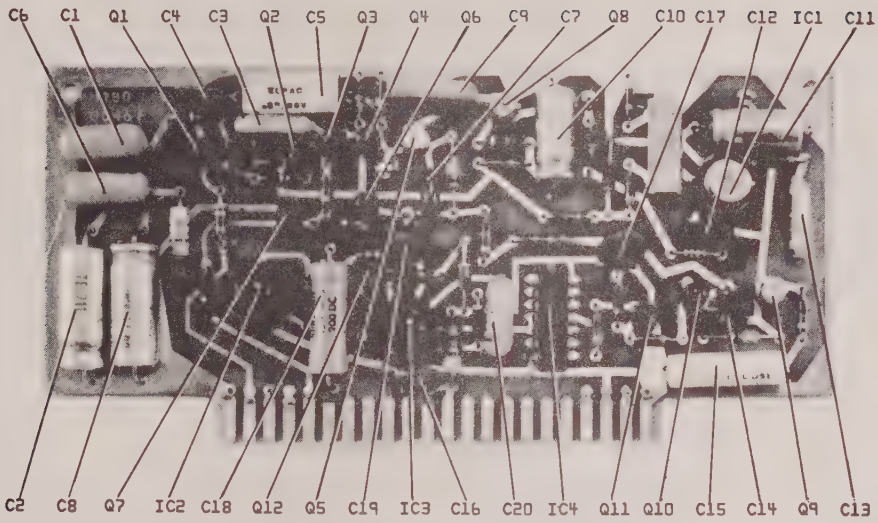
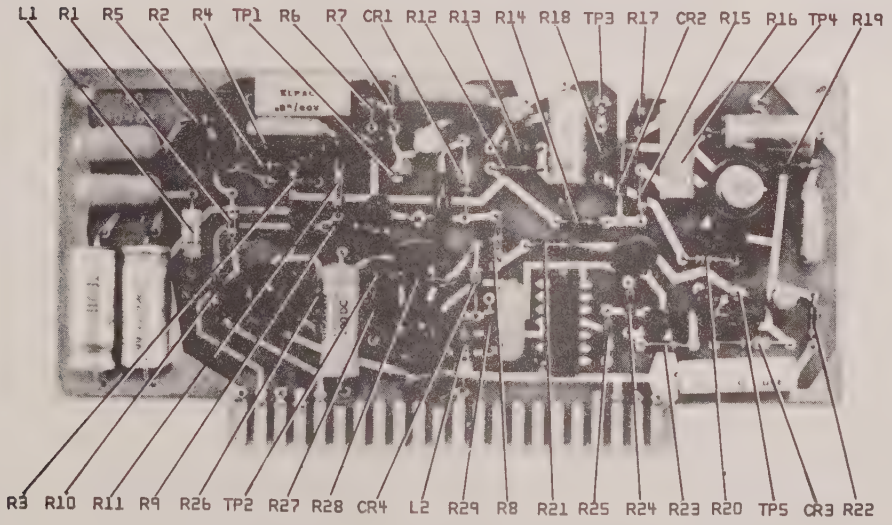


Figure 6-4. Divide-by-N Counter (CH-A12, 0089)

6.3.5 Sample-and-Hold Circuits, CH-A10





6.3.5 SAMPLE-AND-HOLD CIRCUITS, CH-A10

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A10	Sample-and-Hold Circuit Board Assy	7000-0046	Cushman
	Printed Circuit Board, Bare	1780-0046	Cushman
	CAPACITORS		
C1	Mylar, 0.1 MF, 100V	1008-0031	Sprague
C2	Electrolytic, 100 MF, 25V	1013-0003	Sprague
C3	Mylar, 0.22 MF	1008-0024	Sprague
C4	Mica, 180 pF ±5%	1002-0005	Elmenco
C5	Poly, 0.68 MF, 10%, 50V	1008-0039	Elpac
C6	Mylar, 0.1 MF, 100V	1008-0031	Sprague
C7	Mica, 330 pF ±5%	1002-0032	Elmenco
C8	Elect., 100 MF, 25V	1013-0003	Sprague
C9	Mylar, 0.0082, 100V	1008-0015	Sprague
C10	Elect., 25 MF, 25V	1013-0010	Sprague
C11	Elect., 25 MF, 25V	1013-0010	Sprague
C12	Mica, 200 pF ±5%	1002-0042	Elmenco
C13	Mylar, 0.0056 ±10%, 100V	1008-0022	Sprague
C14	Mica, 200 pF ±5%	1002-0042	Elmenco
C15	Poly, 0.39 ±10%, 200V	1008-0037	Electrocube
C16	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C17	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C18	Poly, 0.15 MF ±10%, 200V	1008-0035	Sprague
	DIODES		
CR1	Si, 1N3064	1281-0013	Sylvania
CR2	Zener, 15V, 1N4744	-0024	Dixon
CR3	Si, 1N3064	1281-0013	Sylvania
CR4	Si, 1N4002	1281-0023	Sylvania
	INTEGRATED CIRCUITS		
IC1	OP-AMP 2N72709L	2025-0014	T.I.
IC2	RTL NOR Gate 91428	2025-0010	Fairchild
IC3	RTL NOR Gate 91428	2025-0010	Fairchild
IC4	TTL NAND Gate SN7400N	2025-0003	T.I.
	RESISTORS		
R1	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R2	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R3	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley
R4	Comp, 200kΩ ±5%, 1/4W	1066-2245	Allen-Bradley
R5	Comp, 150kΩ ±5%, 1/4W	1066-1545	Allen-Bradley

6.3.5 SAMPLE-AND-HOLD CIRCUITS, CH-A10 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R6	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R7	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R8	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R9	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R10	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R11	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R12	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R13	Comp, 47kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R14	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R15	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley
R16	Var, 1kΩ, 10%, 1/2W	1215-0004	Helitrim
R17	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R18	Comp, 15kΩ ±5%, 1/4W	1066-1535	Allen-Bradley
R19	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R20	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R21	Comp, 5.6kΩ ±5%, 1/4W	1066-5623	Allen-Bradley
R22	Comp, 1kΩ ±5%,1/4W	1066-1025	Allen-Bradley
R23	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R24	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R25	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R26	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R27	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R28	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R29	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N4275	1272-0016	Fairchild
Q2	Si, PNP, 2N4121	1272-0023	Fairchild
Q3	Si, NPN, 2N5089	1272-0031	Motorola
Q4	Si, NPN, 2N5089	1272-0031	Motorola
Q5	N Channel FET, 2N4092	1272-0025	Amelco
Q6	Si, PNP, 2N4121	1272-0023	Fairchild
Q7	Si, NPN, 2N4275	1272-0016	Fairchild
Q8	P Channel MOS FET, MFM511A	1272-0026	General Inst.
Q9	N Channel FET, 2N4092	1272-0025	Amelco
Q10	Si, PNP, 2N4121	1272-0023	Fairchild
Q11	Si, NPN, 2N4275	1272-0016	Fairchild
Q12	Si, NPN, 2N4275	1272-0016	Fairchild

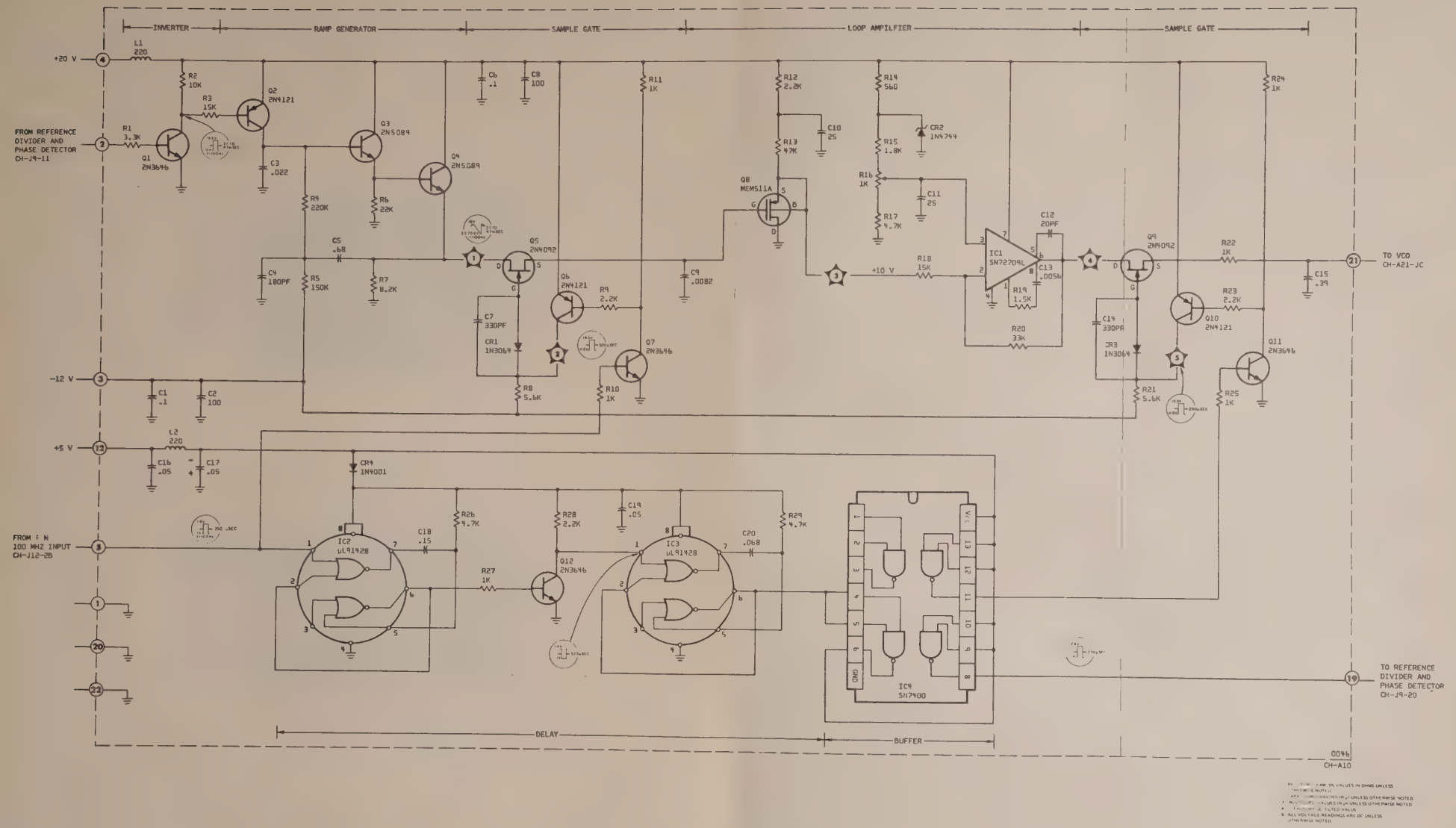
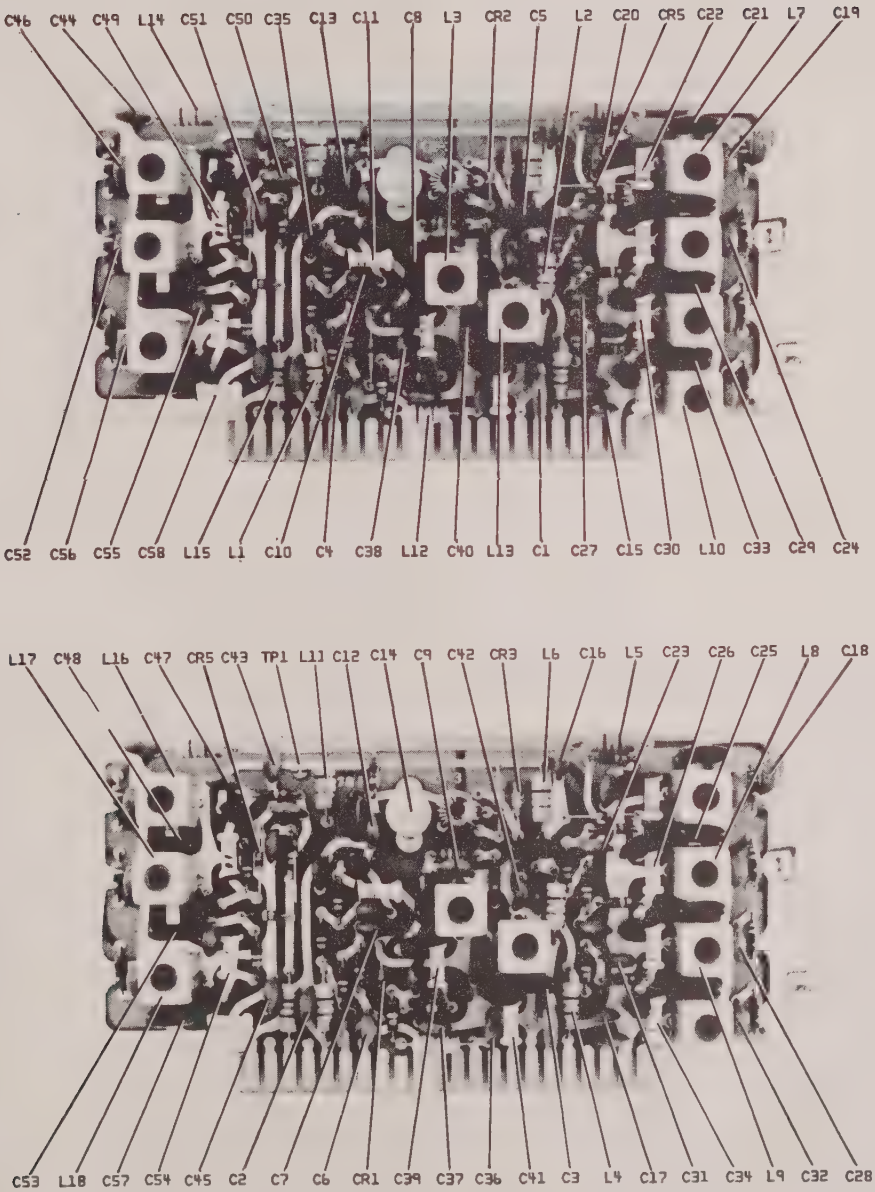
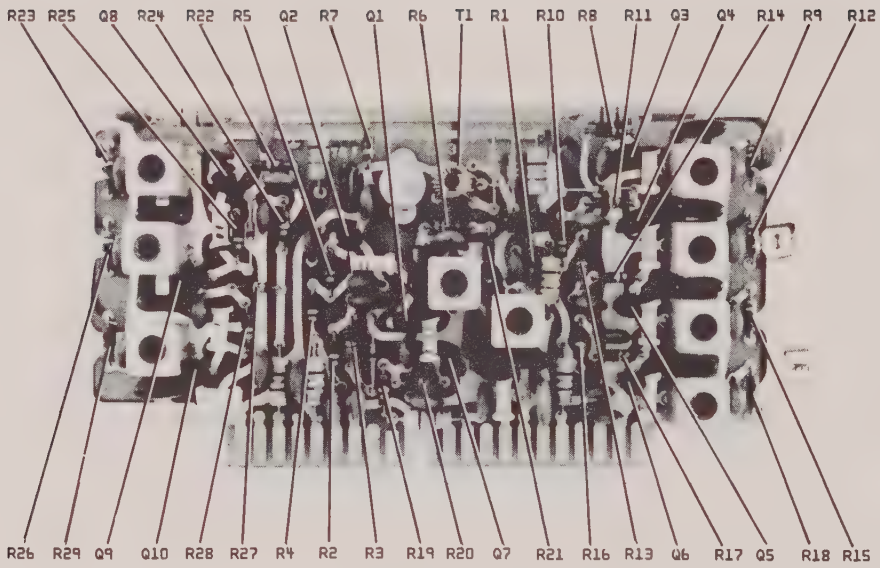


Figure 6-5. Sample-and-Hold Circuits (CH-A10, 0046)

6.3.6 40-MHz, 43-MHz, and 46-MHz Filters, CH-A18





6.3.6 40-MHz, 43-MHz, AND 46-MHz FILTERS, CH-A18

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A18	40-MHz, 43-MHz, and 46-MHz Filters Board Assy	7000-0078	Cushman
	Printed Circuit Board, Bare	1780-0078	Cushman
	CAPACITORS		
C1	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C2	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C3	Mica, 270 pF ±5%, 100V	1002-0031	Elmenco
C4	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C5	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C6	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C7	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C8	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C9	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C10	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C11	Cer, 2.2 pF ±0.25 pF, 500V	1005-0017	Erie
C12	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C13	Mica, 33 pF ±5%, 100V	1002-0024	Elmenco
C14	Var, cer, 9-35 pF	1001-0006	Erie
C15	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C16	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C17	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C18	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C19	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C20	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C21	Mica, 82 pF ±5%, 100V	1002-0020	Elmenco
C22	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C23	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C24	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C25	Mica, 82 pF ±5%, 100V	1002-0020	Elmenco
C26	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C27	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C28	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C29	Mica, 82 pF ±5%, 100V	1002-0020	Elmenco
C30	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C31	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C32	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C33	Mica, 82 pF ±5%, 100V	1002-0020	Elmenco
C34	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C35	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie

6.3.6 40-MHz, 43-MHz, AND 46-MHz FILTERS, CH-A18 (Continued)

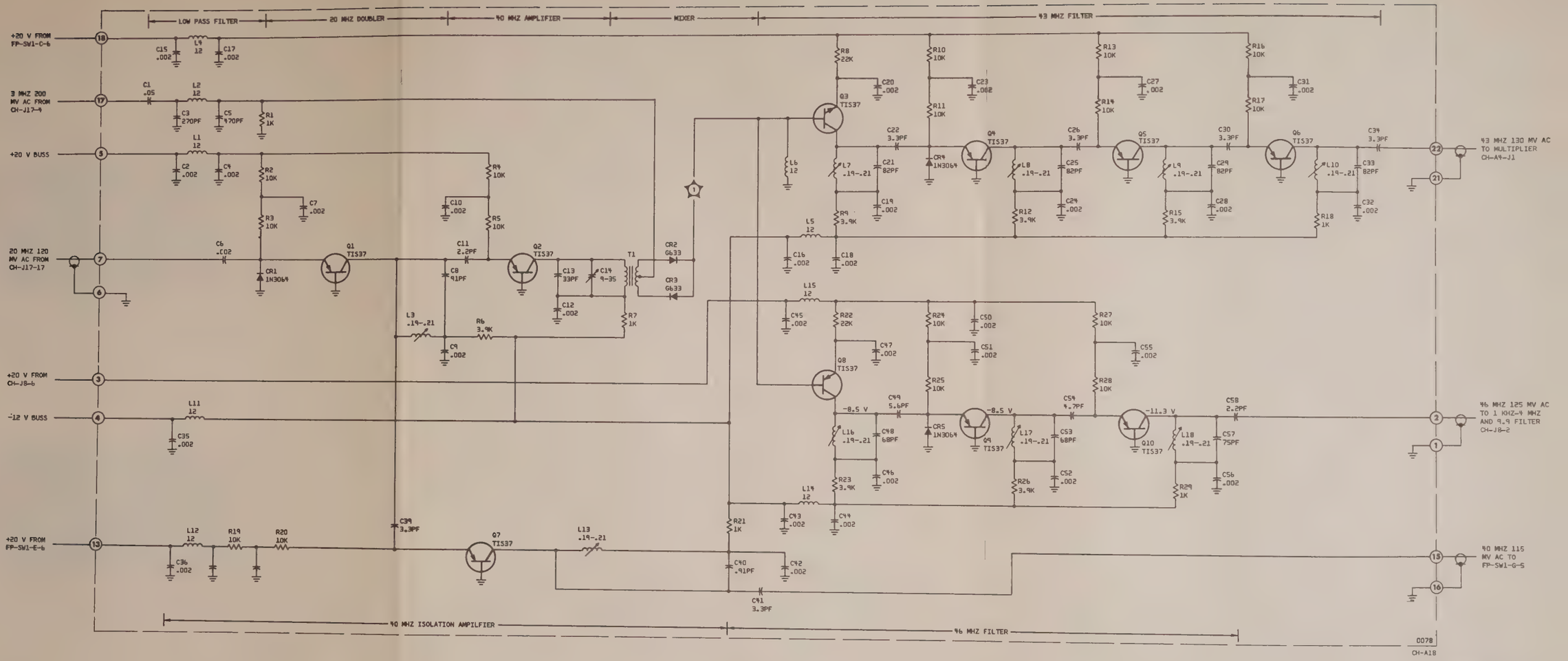
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C36	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C37	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C38	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C39	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C40	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C41	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C42	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C43	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C44	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C45	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C46	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C47	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C48	Mica, 68 pF ±5%, 100V	1002-0013	Elmenco
C49	Cer, 5.6 pF ±0.25 pF, 500V	1005-0042	Erie
C50	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C51	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C52	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C53	Mica, 68 pF ±5%, 100V	1002-0013	Elmenco
C54	Cer, 4.7 ±0.25 pF, 500V	1005-0015	Erie
C55	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C56	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C57	Mica, 75 pF ±2%, 100V	1002-0025	Elmenco
C58	Cer, 2.2 pF ±0.25 pF, 500V	1005-0017	Erie
	COILS		
L1	RF Choke, 12 μH ±10%	1585-0011	Delevan
L2	RF Choke, 12 μH ±10%	1585-0011	Delevan
L3	Var, 0.19-0.21 μH	1596-0010	TRW
L4	RF Choke, 12 μH ±10%	1585-0011	Delevan
L5	RF Choke, 12 μH ±10%	1585-0011	Delevan
L6	RF Choke, 12 μH ±10%	1585-0011	Delevan
L7	Var, 0.19-0.21 μH	1596-0010	TRW
L8	Var, 0.19-0.21 μH	1596-0010	TRW
L9	Var, 0.19-0.21 μH	1596-0010	TRW
L10	Var, 0.19-0.21 μH	1596-0010	TRW
L11	RF Choke, 12 μH ±10%	1585-0011	Delevan
L12	RF Choke, 12 μH ±10%	1585-0011	Delevan
L13	Var, 0.19-0.21 μH	1596-0010	TRW
L14	RF Choke, 12 μH ±10%	1585-0011	Delevan
L15	RF Choke, 12 μH ±10%	1585-0011	Delevan

6.3.6 40-MHz, 43-MHz, AND 46-MHz FILTERS, CH-A18 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
L16	Var, 0.19-0.21 μH	1596-0010	TRW
L17	Var, 0.19-0.21 μH	1596-0010	TRW
L18	Var, 0.19-0.21 μH	1596-0010	TRW
	DIODES		
CR1	Si, 1N3064	1281-0013	Transitron
CR2	Ge, G633	1282-0005	ITT
CR3	Ge, G633	1282-0005	ITT
CR4	Si, 1N3064	1281-0013	Transitron
CR5	Si, 1N3064	1281-0013	Transitron
	RESISTORS		
R1	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R2	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R4	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R5	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R6	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R7	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R8	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R9	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R10	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R11	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R12	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R14	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R15	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R16	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R17	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R18	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R19	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R20	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R21	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R22	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R23	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R24	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R25	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R26	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R27	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R28	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R29	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley

6.3.6 40-MHz, 43-MHz, AND 46-MHz FILTERS, CH-A18 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	TRANSFORMERS		
T1	Toroid	1579-0007	Cushman
	TRANSISTORS		
Q1	Si, TIS37	1271-0003	T.I.
Q2	Si, TIS37	1271-0003	T.I.
Q3	Si, TIS37	1271-0003	T.I.
Q4	Si, TIS37	1271-0003	T.I.
Q5	Si, TIS37	1271-0003	T.I.
Q6	Si, TIS37	1271-0003	T.I.
Q7	Si, TIS37	1271-0003	T.I.
Q8	Si, TIS37	1271-0003	T.I.
Q9	Si, TIS37	1271-0003	T.I.
Q10	Si, TIS37	1271-0003	T.I.



1. RESISTORS 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS VALUES IN μf UNLESS OTHERWISE NOTED
3. INDUCTORS VALUES IN μh UNLESS OTHERWISE NOTED
4. * FACTORY SELECTED VALUE
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

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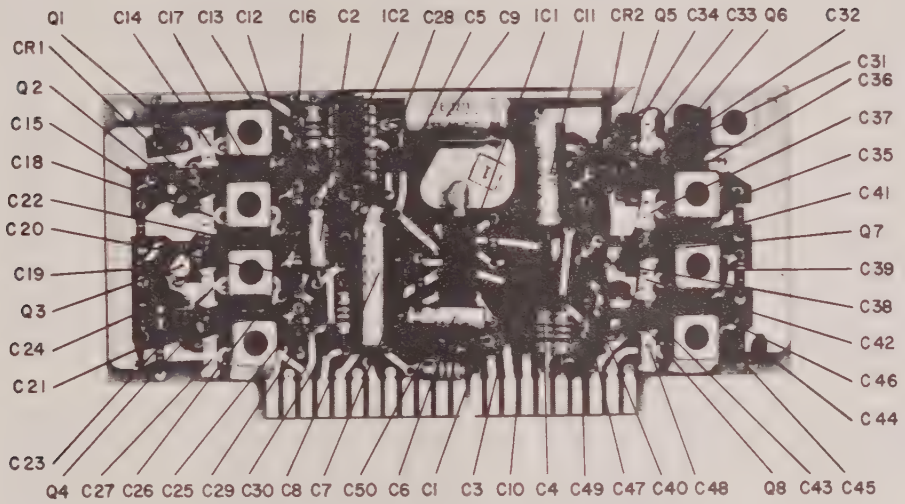
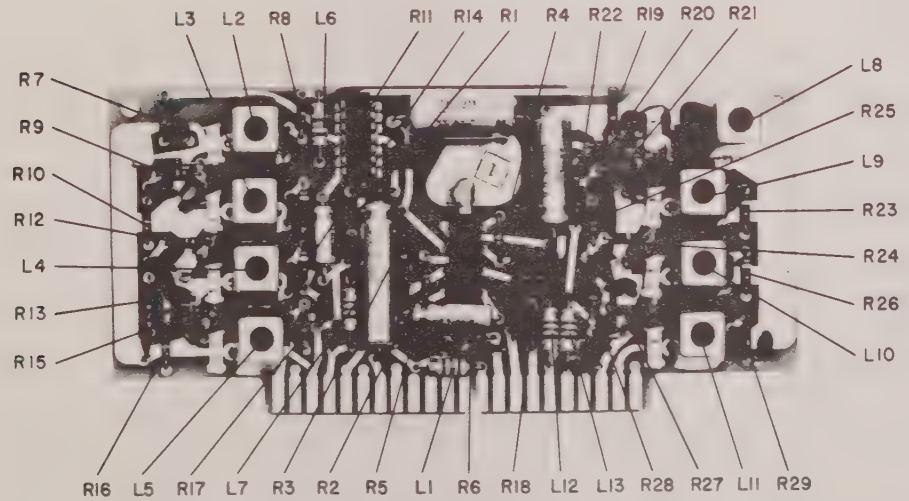
Figure 6-6. 40-MHz, 43-MHz, and 46-MHz Filters (CH-A18, 0078)

6.3.7 33-MHz and 42-MHz Filters, and Audio Amplifier, CH-A16





6.3.7 33-MHz, 42-MHz FILTERS AND AUDIO AMPLIFIER, CH-A16

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A16	33-MHz, 42-MHz Filters and Audio Board Amplifier Assy	7000-0064	Cushman
	Printed Circuit Board, Bare	1780-0064	Cushman
	CAPACITORS		
C1	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C2	Elect., 1 MH, 25V	1013-0004	Sprague
C3	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C4	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C5	Mica, 51 pF ±5%, 100V	1002-0045	Elmenco
C6	Elect., 15 MF, 25V	1013-0005	Sprague
C7	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C8	Elect., 250 MF, 12V	1013-0012	Sprague
C9	Elect., 100 MF, 25V	1013-0003	Sprague
C10	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C11	Elect., 100 MF, 25V	1013-0003	Sprague
C12	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C13	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C14	Cer, 3.3 pF ± 0.25 pF, 500V	1005-0011	Sprague
C15	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C16	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C17	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C18	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Sprague
C19	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C20	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C21	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C22	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C23	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Sprague
C24	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C25	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C26	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C27	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Sprague
C28	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C29	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C30	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C31	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C32	Mica, 150 pF ±5%, 100V	1002-0021	Elmenco
C33	Cer, 4.7 pF ±0.25 pF, 500V	1005-0015	Sprague
C34	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C35	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie

6.3.7 33-MHz, 42-MHz FILTERS AND AUDIO AMPLIFIER, CH-A16 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C36	Mica, 150 pF ±5%, 100V	1002-0021	Elmenco
C37	Cer, 4.7 pF ±0.25 pF, 500V	1005-0015	Sprague
C38	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C39	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C40	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C41	Mica, 150 pF ±5%, 100V	1002-0021	Elmenco
C42	Cer, 4.7 pF ±0.25%, 500V	1005-0015	Sprague
C43	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C44	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C45	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C46	Mica, 150 pF ±5%, 100V	1002-0021	Elmenco
C47	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C48	Cer, 4.7 pF ±0.25 pF, 500V	1005-0015	Sprague
C49	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C50	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
	COILS		
L1	RF Choke, 220 µH ±5%	1585-0018	Delevan
L2	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L3	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L4	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L5	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L6	RF Choke, 15 µH ±10%	1585-0034	Delevan
L7	RF Choke, 15 µH ±10%	1585-0034	Delevan
L8	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L9	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L10	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L11	Var Inductor, 0.19-0.21 µH	1596-0010	TRW
L12	RF Choke, 15 µH ±10%	1585-0034	Delevan
L13	RF Choke, 15 µH ±10%	1585-0034	Delevan
	DIODES		
CR1	Si, 1N3064	1281-0013	Transitron
CR2	Si, 1N3064	1281-0013	Transitron
	INTEGRATED CIRCUITS		
IC1	Audio Amp., PA-222	2025-0015	G.E.
IC2	TTL, Gate Package SN7400N	2025-0003	T.I.

6.3.7 33-MHz, 42-MHz FILTERS AND AUDIO AMPLIFIER, CH-A16 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	RESISTORS		
R1	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R2	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R3	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R4	Comp, 100kΩ ±5%, 1/4W	1066-1045	Allen-Bradley
R5	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R6	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley
R7	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R8	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R9	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R10	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R11	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R12	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R14	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R15	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R16	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R17	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R18	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley
R19	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R20	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R21	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R22	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R23	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R24	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R25	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R26	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R27	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R28	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R29	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, PNP, TIS37	1271-0003	T.I.
Q3	Si, PNP, TIS37	1271-0003	T.I.
Q4	Si, PNP, TIS37	1271-0003	T.I.
Q5	Si, NPN, 2N3563	1272-0022	Fairchild
Q6	Si, PNP, TIS37	1271-0003	T.I.
Q7	Si, PNP, TIS37	1271-0003	T.I.
Q8	Si, PNP, TIS37	1271-0003	T.I.

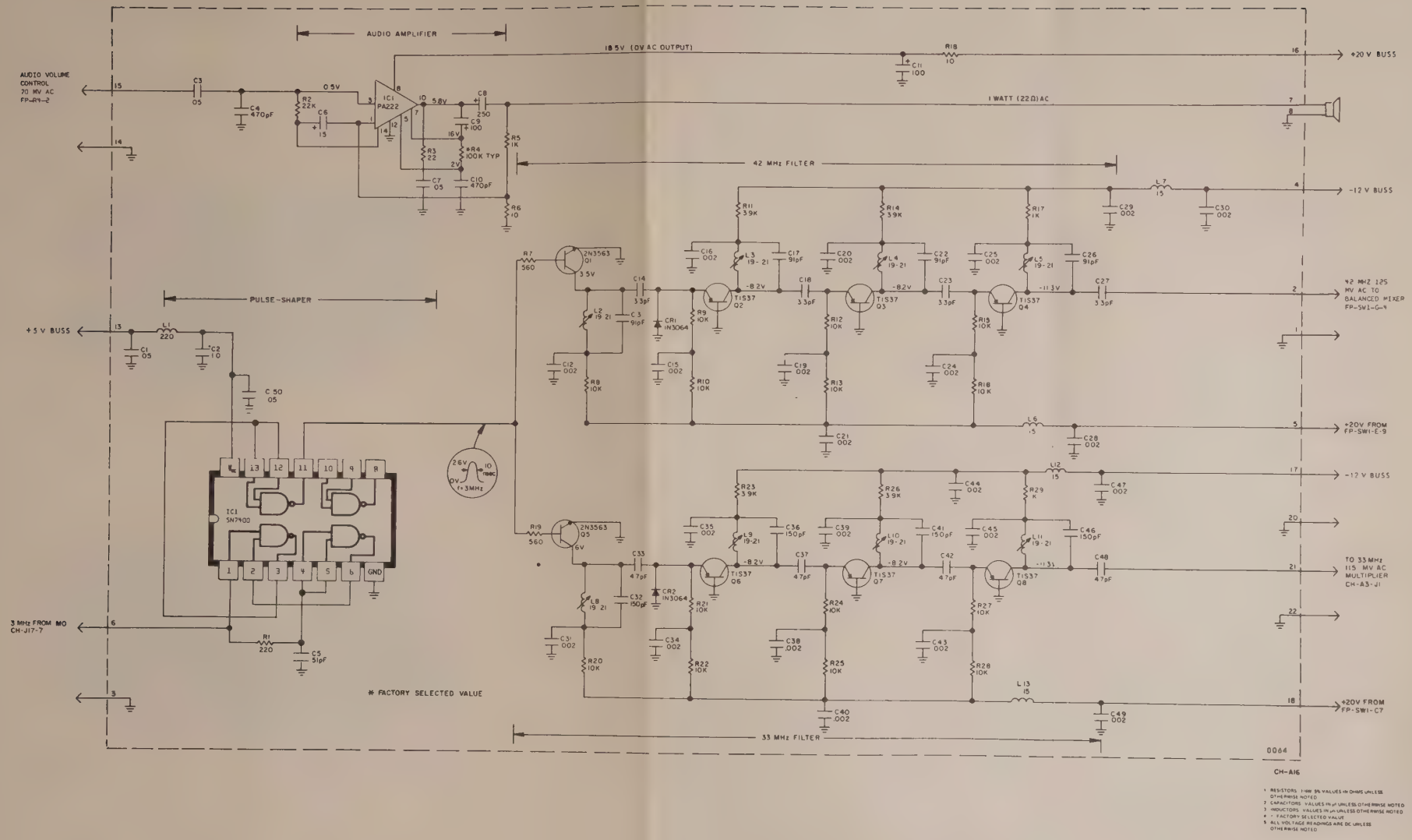
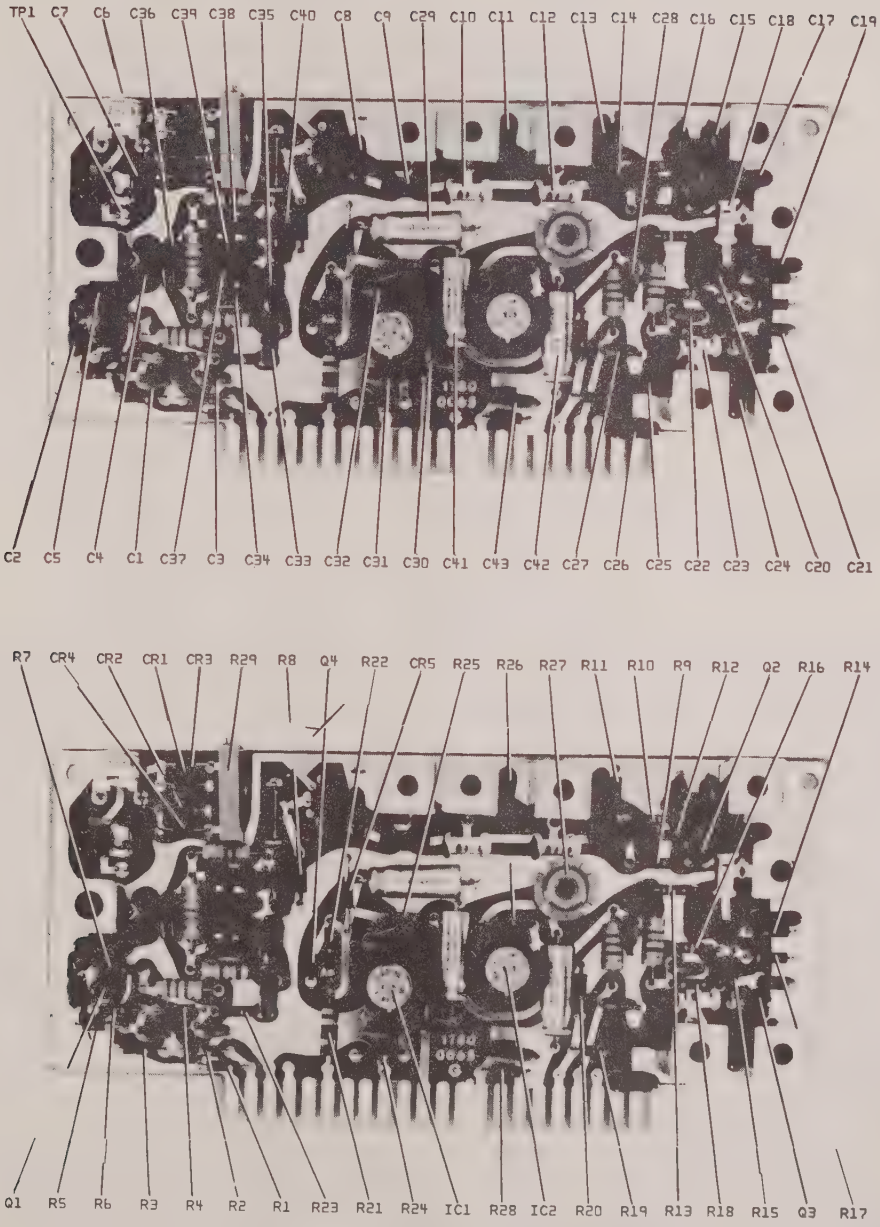
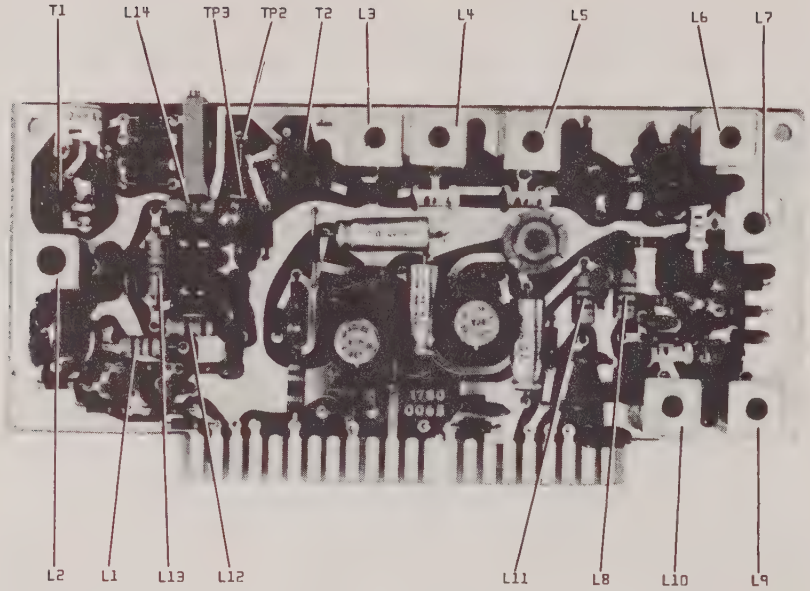


Figure 6-7. 33-MHz and 42-MHz Filters and Audio Amplifier (CH-A16, 0064)

5601**0009

6.3.8 Balanced Mixer, CH-A15





6.3.8 BALANCED MIXER, CH-A15

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A15	Balanced Mixer Board Assy	7000-0065	Cushman
	Printed Circuit Board, Bare	1780-0065	Cushman
	CAPACITORS		
C1	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C2	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C3	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C4	Mica, 33 pF ±5%, 100V	1002-0024	Elmenco
C5	Mica, 68 pF ±5%, 100V	1002-0013	Elmenco
C6	Cer, var, 2-8 pF	1001-0010	Erie
C7	Mica, 5 pF ±5%, 100V	1002-0028	Erie
C8	Mica, 100 pF ±5%, 100V	1002-0011	Elmenco
C9	Mica, 91 pF ±5%, 100V	1002-0027	Elmenco
C10	Cer, 5.6 pF ±0.25 pF, 500V	1005-0042	Erie
C11	Mica, 33 pF ±5%, 100V	1002-0024	Elmenco
C12	Cer, 5.6 pF ±0.25 pF, 500V	1005-0042	Erie
C13	Mica, 43 pF ±5%, 100V	1002-0046	Elmenco
C14	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C15	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C16	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C17	Mica, 43 pF ±5%, 100V	1002-0046	Elmenco
C18	Cer, 6.8 pF ±0.25 pF, 500V	1005-0006	Erie
C19	Mica, 39 pF ±5%, 100V	1002-0018	Elmenco
C20	Mica, 15 pF ±5%, 100V	1002-0001	Elmenco
C21	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C22	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C23	Cer, 8.2 pF ±0.25 pF, 500V	1005-0043	Erie
C24	Mica, 43 pF ±5%, 100V	1002-0046	Elmenco
C25	Mica, 68 pF ±5%, 100V	1002-0013	Elmenco
C26	Mica, 120 pF ±5%, 100V	1002-0010	Elmenco
C27	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C28	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C29	Elect., 15 MF, 25V	1013-0005	Sprague
C30	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C31	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C32	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C33	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C34	Mica, 56 pF ±5%, 100V	1002-0019	Elmenco
C35	Mica, 330 pF ±5%, 100V	1002-0032	Elmenco

6.3.8 BALANCED MIXER, CH-A15 (Continued)

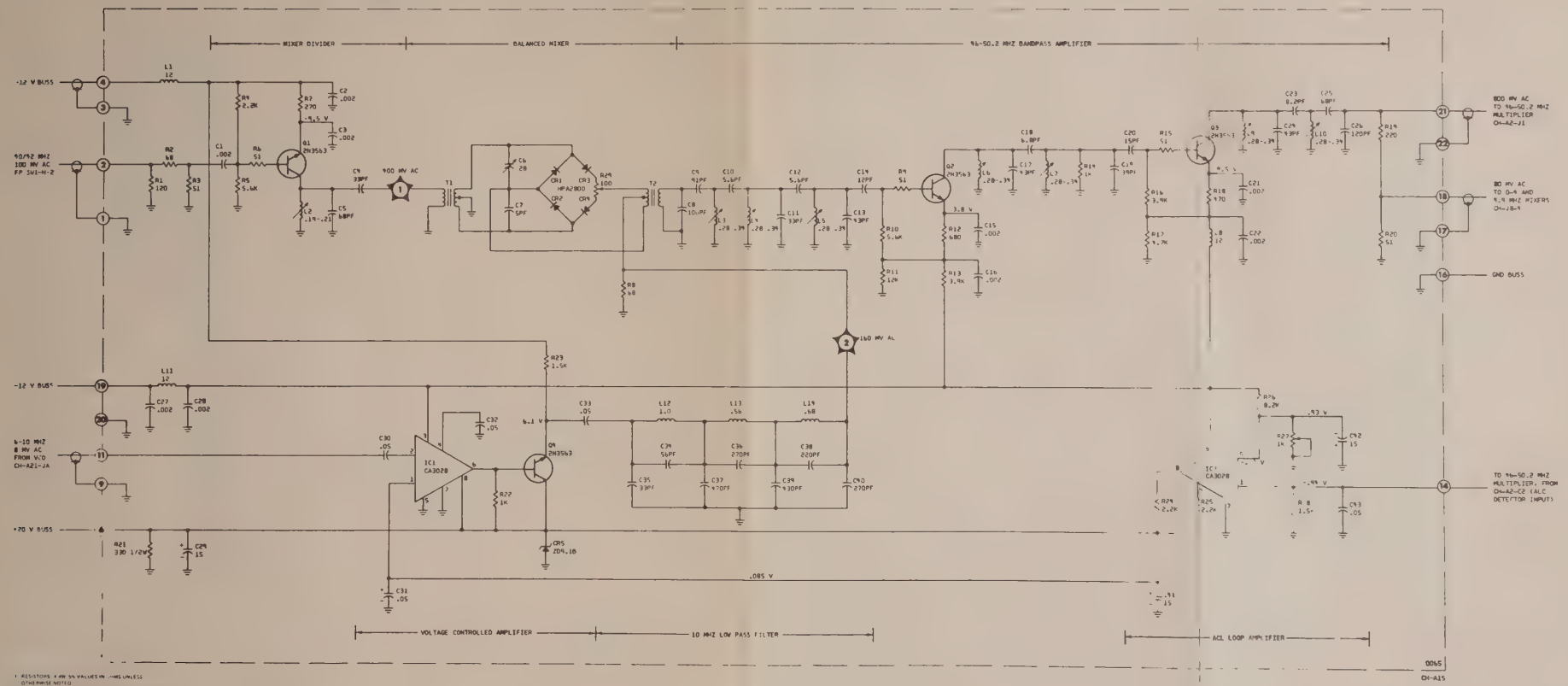
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C36	Mica, 270 pF ±5%, 100V	1002-0031	Elmenco
C37	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C38	Mica, 430 pF ±5%, 100V	1002-0034	Elmenco
C39	Mica, 220 pF ±5%, 100V	1002-0029	Elmenco
C40	Mica, 270 pF ±5%, 100V	1002-0031	Elmenco
C41	Elect., 15 MF, 25V	1013-0005	Sprague
C42	Elect., 15 MF, 25V	1013-0005	Sprague
C43	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
	COILS		
L1	RF Choke, 12 μH ±10%	1585-0011	Delevan
L2	Var Inductor, 0.19-0.21 μH	1596-0010	Cushman
L3	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L4	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L5	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L6	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L7	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L8	RF Choke, 12 μH ±10%	1585-0011	Delevan
L9	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L10	Var Inductor, 0.28-0.34 μH	7050-0021	Cushman
L11	RF Choke, 12 μH ±10%	1585-0011	Delevan
L12	RF Choke, 1 μH ±10±	1584-0027	Delevan
L13	RF Choke, 0.56 μH ±10%	1585-0036	Delevan
L14	RF Choke, 0.68 μH ±10%	1585-0024	Delevan
	DIODES		
CR1	Hot Carrier, HPA2800	1283-0001	HPA
CR2	Hot Carrier, HPA2800	1283-0001	HPA
CR3	Hot Carrier, HPA2800	1283-0001	HPA
CR4	Hot Carrier, HPA2800	1283-0001	HPA
CR5	Zener, 9.1V, 1N4739	1281-0027	Semcor
	INTEGRATED CIRCUITS		
IC1	RF Ampl, CA3028A	2025-0012	RCA
IC2	RF Ampl, CA3028A	2025-0012	RCA
	RESISTORS		
R1	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R2	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
R3	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R5	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley

6.3.8 BALANCED MIXER, CH-A15 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R6	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R7	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R8	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
R9	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R10	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R11	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R12	Comp, 680Ω ±5%, 1/4W	1066-6815	Allen-Bradley
R13	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R14	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R15	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R16	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R17	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R18	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R19	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R20	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R21	Comp, 330Ω ±5%, 1/2W	1067-3315	Allen-Bradley
R22	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R23	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R24	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R25	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley

6.3.8 BALANCED MIXER, CH-A15 (Continued)

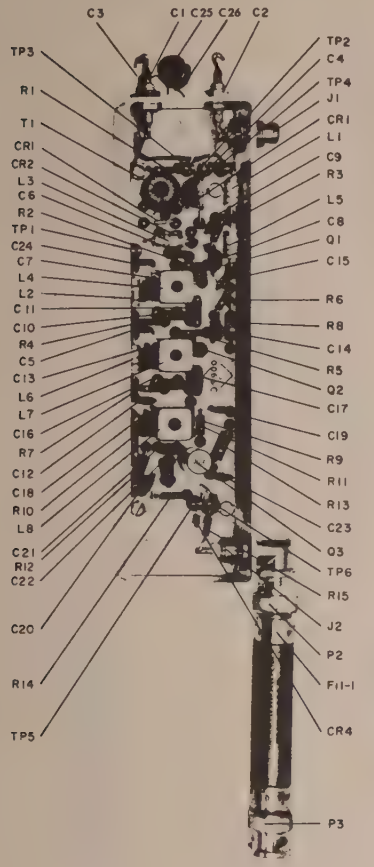
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R26	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R27	Pot, comp, 1kΩ ±20%, 1/4W	1200-0012	Allen-Bradley
R28	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R29	Cer, var, 100Ω	1206-0018	CTS
	TRANSFORMERS		
T1	Transformer	1579-0016	Cushman
T2	Transformer	1579-0016	Cushman
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, NPN, 2N3563	1272-0022	Fairchild
Q3	Si, NPN, 2N3563	1272-0022	Fairchild
Q4	Si, NPN, 2N3563	1272-0022	Fairchild



1. RESISTORS 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS VALUES IN μF UNLESS OTHERWISE NOTED
3. INDUCTORS VALUES IN μH UNLESS OTHERWISE NOTED
4. FACTORY SELECTED VALUE
ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-8. Balanced Mixer (CH-A15, 0065)

6.3.9 46-to-50.2-MHz Multiplier and Filter, CH-A2

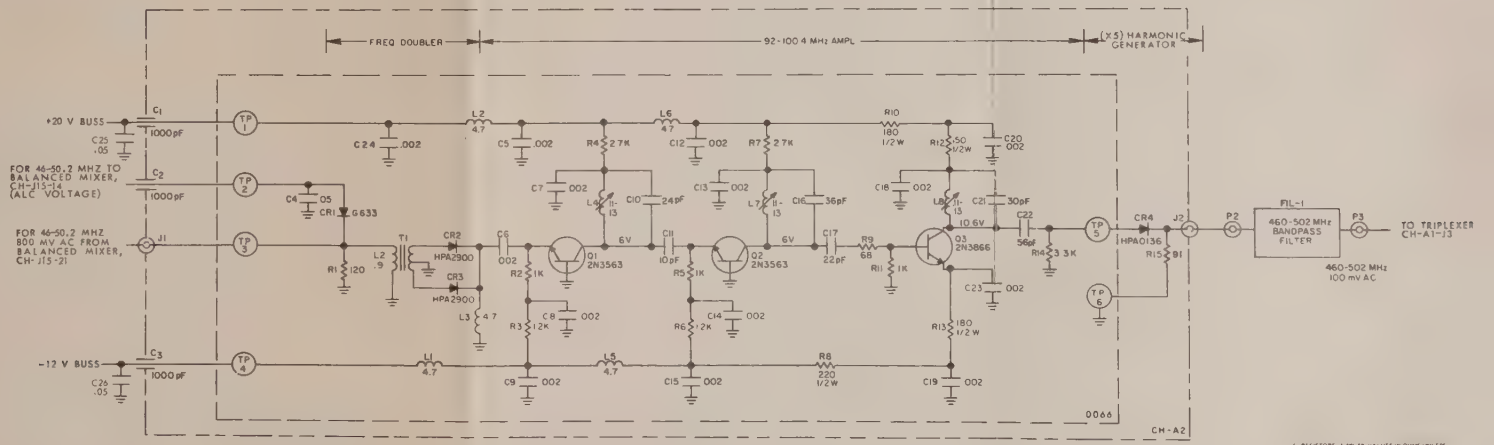


6.3.9 46-TO-50.2-MHz MULTIPLIER AND FILTER

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A2	460 to 50.2 MHz Assy	7046-0003	Cushman
CH-A2-FIL-1	460 to 50.2 MHz Filter, Coaxial	1040-0010	Texscan
	460 to 50.2 Multiplier Board Assy	7000-0068	Cushman
	Printed Circuit Board, Bare	1780-0066	Cushman
	CAPACITORS		
C1	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
C2	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
C3	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
C4	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C5	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C6	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C7	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C8	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C9	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C10	Mica, 24 pF ±5%, 100V	1002-0051	Elmenco
C11	Mica, 10 pF ±5%, 100V	1002-0016	Elmenco
C12	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C13	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C14	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C15	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C16	Mica, 36 pF ±5%, 100V	1002-0041	Elmenco
C17	Mica, 22 pF ±5%, 100V	1002-0023	Elmenco
C18	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C19	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C20	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C21	Mica, 30 pF ±5%, 100V	1002-0043	Elmenco
C22	Mica, 56 pF ±5%, 100V	1002-0019	Elmenco
C23	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C24	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C25	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C26	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
	COILS		
L1	RF Choke, 4.7 µH ±20%	1585-0021	Delevan
L2	RF Choke, 4.7 µH ±20%	1585-0021	Delevan
L3	RF Choke, 4.7 µH ±20%	1585-0021	Delevan
L4	Var Inductor, 0.11-0.13 µH	7050-0022	Cushman
L5	RF Choke, 4.7 µH ±20%	1585-0021	Delevan

6.3.9 46-TO-50.2-MHz MULTIPLIER AND FILTER (Continued)

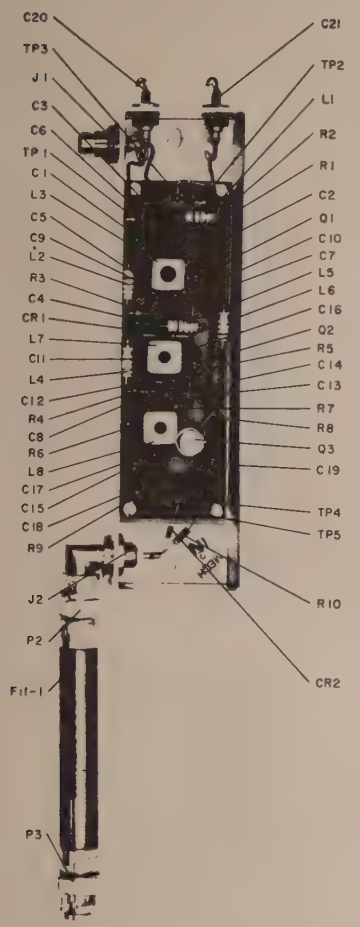
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
L6	RF Choke, 4.7 µH ±20%	1585-0021	Delevan
L7	Var Inductor, 0.11-0.13 µH	7050-0022	Cushman
L8	Var Inductor, 0.11-0.13 µH	7050-0022	Cushman
	DIODES		
CR1	Ge, G633	1282-0005	ITT
CR2	Hot Carrier, HPA2900	1283-0001	HPA
CR3	Hot Carrier, HPA2900	1283-0001	HPA
CR4	Si, HPA0136	1282-0006	HPA
	RESISTORS		
R1	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R2	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R3	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R4	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R5	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R6	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R7	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R8	Comp, 220Ω ±5%, 1/2W	1067-2215	Allen-Bradley
R9	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
R10	Comp, 180Ω ±5%, 1/2W	1067-1815	Allen-Bradley
R11	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R12	Comp, 150Ω ±5%, 1/2W	1067-1515	Allen-Bradley
R13	Comp, 180Ω ±5%, 1/2W	1067-1815	Allen-Bradley
R14	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R15	Comp, 91Ω ±5%, 1/4W	1066-9105	Allen-Bradley
	TRANSFORMERS		
T1	Toroid	1579-0013	Cushman
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, NPN, 2N3563	1272-0022	Fairchild
Q3	Si, NPN, 2N3866	1271-0005	RCA



1. RESISTOR 1 OHM 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS VALUES IN µF UNLESS OTHERWISE NOTED
3. INDUCTORS VALUES IN µH UNLESS OTHERWISE NOTED
4. * FACTORY SELECTED VALUE
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-9. 46-to-50.2-MHz Multiplier (CH-A2, 0066)

6.3.10 33-MHz Multiplier and Filter, CH-A3

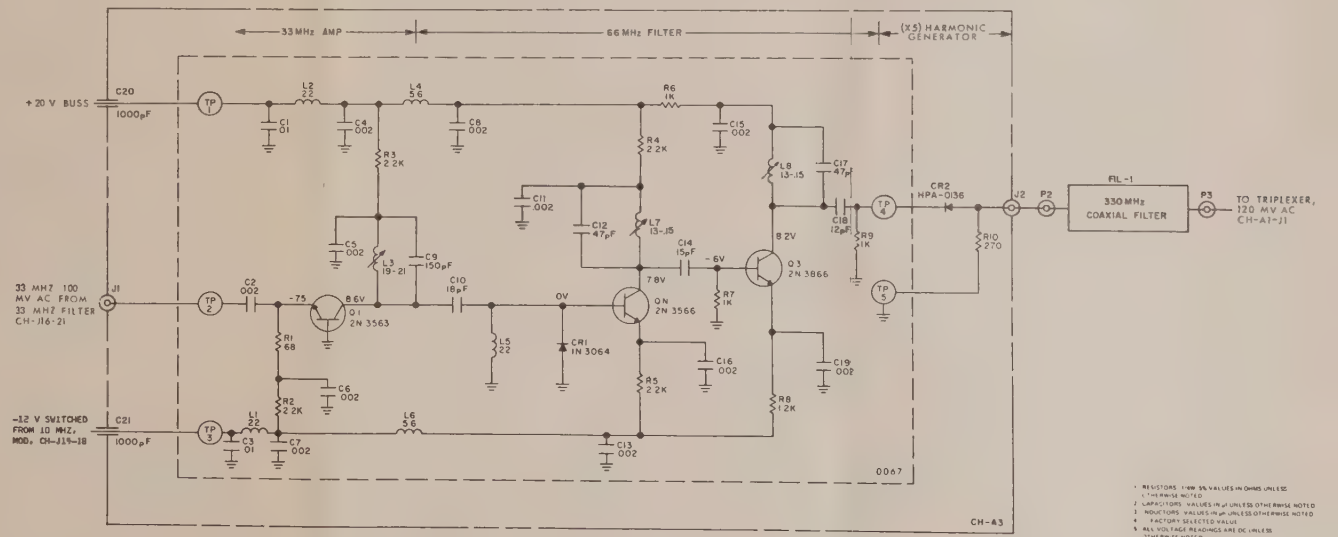


6.3.10 33-MHz MULTIPLIER AND FILTER, CH-A3

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A3	330 MHz Assy	7046-0001	Cushman
CH-A3-FIL-1	330 MHz Filter, Coaxial	1040-0008	Texscan
	33 MHz Multiplier Board Assy	7000-0048	Cushman
	Printed Circuit Board, Bare	1780-0067	Cushman
	CAPACITORS		
C1	Cer, 0.01 MF +80%-20%, 50V	1005-0013	Erie
C2	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C3	Cer, 0.01 MF +80%-20%, 50V	1005-0013	Erie
C4	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C5	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C6	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C7	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C8	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C9	Mica, 150 pF ±5%, 100V	1002-0021	Elmenco
C10	Mica, 18 pF ±5%, 100V	1002-0014	Elmenco
C11	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C12	Mica, 47 pF ±5%, 100V	1002-0012	Elmenco
C13	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C14	Mica, 15 pF ±5%, 100V	1002-0001	Elmenco
C15	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C16	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C17	Mica, 47 pF ±5%, 100V	1002-0012	Elmenco
C18	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C19	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C20	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
C21	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
	COILS		
L1	RF Choke, 22 μH ±10%	1585-0012	Delevan
L2	RF Choke, 22 μH ±10%	1585-0012	Delevan
L3	Var Inductor, 0.19-0.21 μH	1596-0010	Cushman
L4	RF Choke, 5.6 μH ±10%	1585-0028	Delevan
L5	RF Choke, 22 μH ±10%	1585-0012	Delevan
L6	RF Choke, 5.6 μH ±10%	1585-0028	Delevan
L7	Var Inductor, 0.13-0.15 μH	7050-0005	Cushman
L8	Var Inductor, 0.13-0.15 μH	7050-0005	Cushman

6.3.10 33-MHz MULTIPLIER AND FILTER, CH-A3 (Continued)

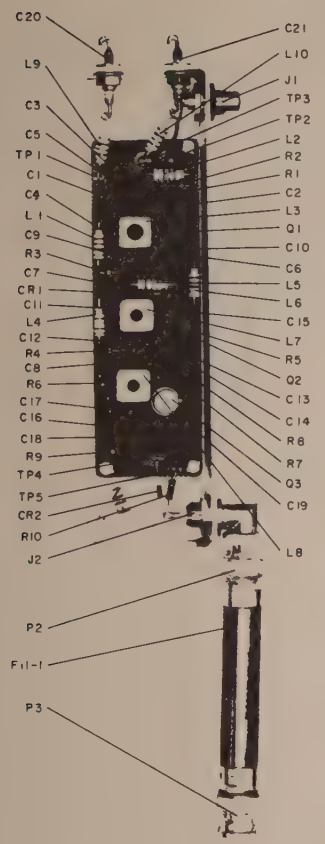
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	DIODES		
CR1	Si, 1N3064	1281-0013	Transitron
CR2	Si, HPA0136	1282-0006	HPA
	RESISTORS		
R1	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
R2	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R3	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R5	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R6	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R7	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R8	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R10	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, NPN, 2N3563	1272-0022	Fairchild
Q3	Si, NPN, 2N3866	1271-0005	RCA



1. RESISTORS 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS VALUES IN μF UNLESS OTHERWISE NOTED
3. INDUCTORS VALUES IN μH UNLESS OTHERWISE NOTED
4. * FACTORY SELECTED VALUE
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-10. 33-MHz Multipliers (CH-A3, 0067)

6.3.11 43-MHz Multiplier and Filter, CH-A4

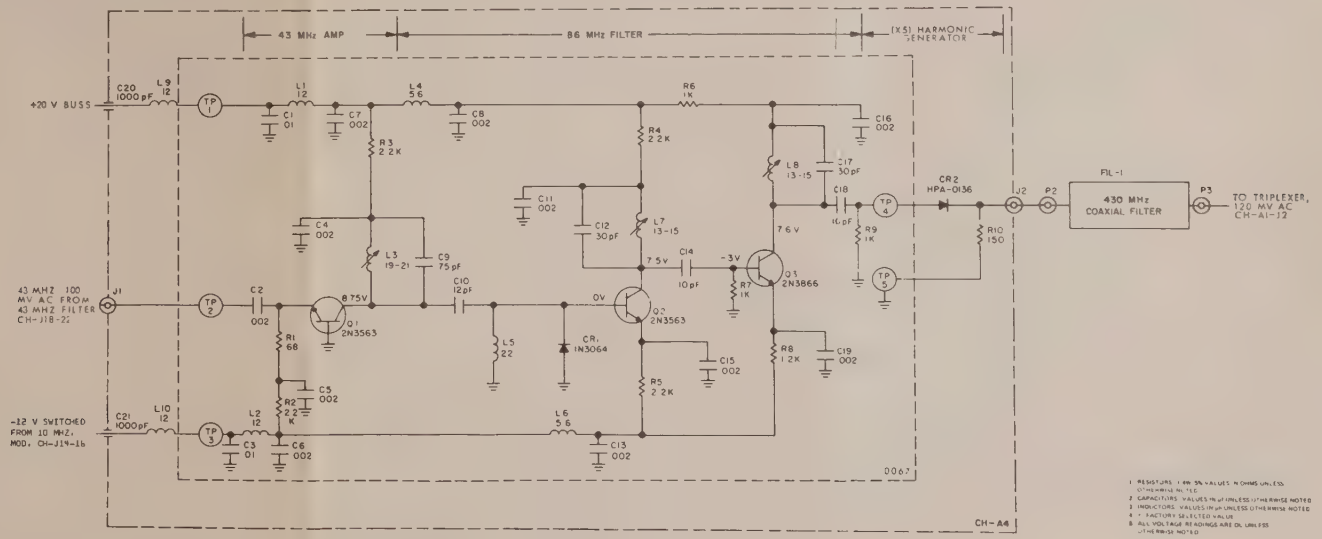


6.3.11 43-MHz MULTIPLIER AND FILTER, CH-A4

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A4	430 MHz Assy	7046-0002	Cushman
CH-A4-FIL-1	430 MHz Filter, Coaxial	1040-0009	Texscan
	43 MHz Multiplier Board Assy	7000-0067	Cushman
	Printed Circuit Board, Bare	1780-0067	Cushman
	CAPACITORS		
C1	Cer, 0.01 MF +80% -20%, 50V	1005-0013	Erie
C2	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C3	Cer, 0.01 MF +80% -20%, 50V	1005-0013	Erie
C4	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C5	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C6	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C7	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C8	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C9	Mica, 75 pF ±5%, 100V	1002-0025	Elmenco
C10	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C11	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C12	Mica, 30 pF ±5%, 100V	1002-0043	Elmenco
C13	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C14	Mica, 10 pF ±5%, 100V	1002-0016	Elmenco
C15	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C16	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C17	Mica, 30 pF ±5%, 100V	1002-0043	Elmenco
C18	Mica, 10 pF ±5%, 100V	1002-0016	Elmenco
C19	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C20	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
C21	Feedthru, 1000 pF ±20%, 500V	1005-0008	Erie
	COILS		
L1	RF Choke, 12 μH ±10%	1545-0011	Delevan
L2	RF Choke, 12 μH ±10%	1545-0011	Delevan
L3	Var Inductor, 0.19-0.21 μH	1596-0010	Cushman
L4	RF Choke, 5.6 μH ±10%	1545-0028	Delevan
L5	RF Choke, 22 μH ±10%	1545-0012	Delevan
L6	RF Choke, 5.6 μH ±10%	1545-0028	Delevan
L7	Var Inductor, 0.13-0.15 μH	7050-0005	Cushman
L8	Var Inductor, 0.13-0.15 μH	7050-0005	Cushman
L9	RF Choke, 12 μH ±10%	1545-0011	Delevan
L10	RF Choke, 12 μH ±10%	1545-0011	Delevan

6.3.11 43-MHz MULTIPLIER AND FILTER, CH-A4 (Continued)

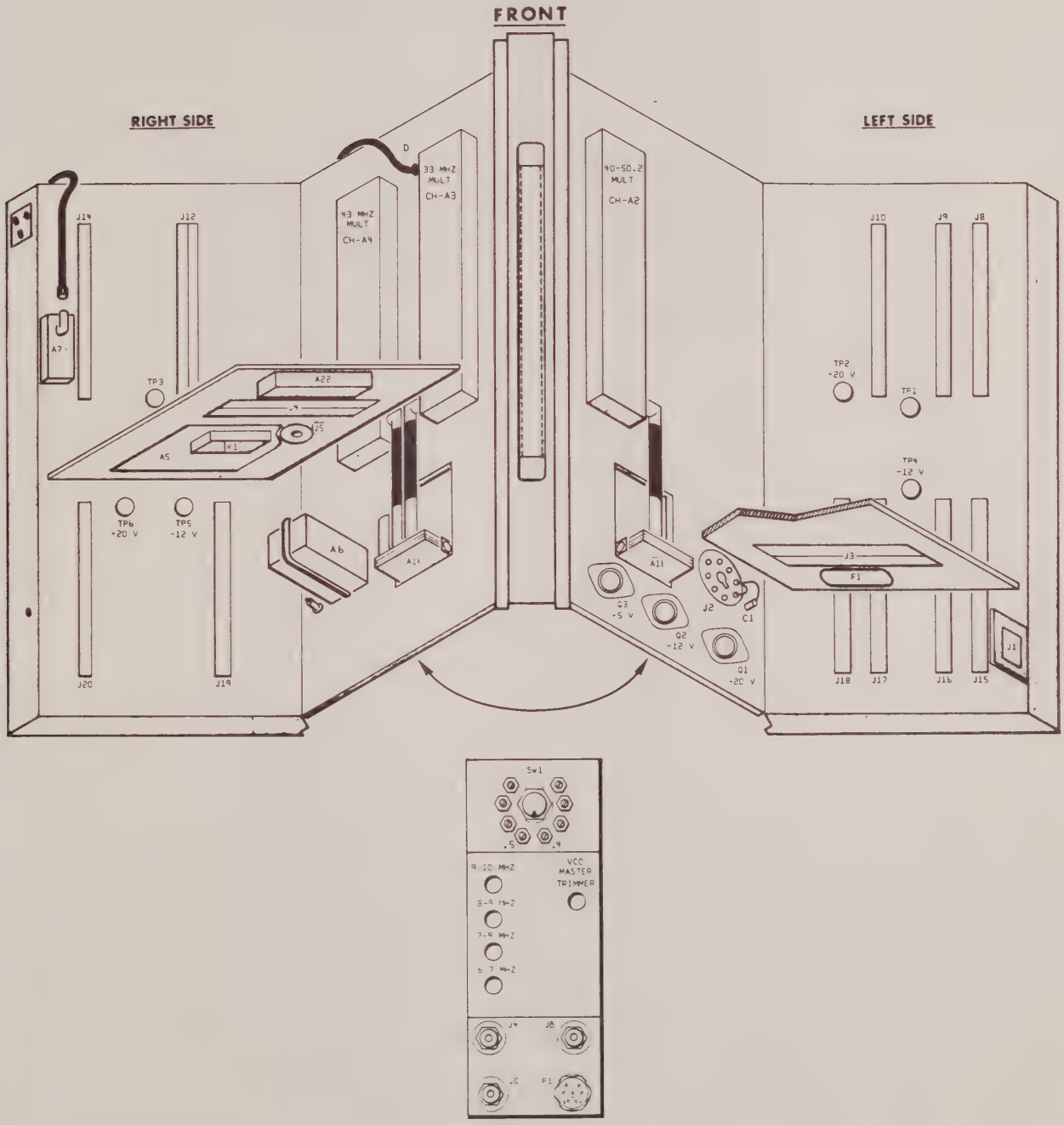
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	DIODES		
CR1	Si, 1N3064	1281-0013	Transitron
CR2	Si, HPA0136	1282-0006	HPA
	RESISTORS		
R1	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
R2	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R3	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R4	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R5	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R6	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R7	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R8	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R10	Comp, 150Ω ±5%, 1/4W	1066-1515	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, NPN, 2N3563	1272-0022	Fairchild
Q3	Si, NPN, 2N3866	1271-0005	RCA



1. RESISTORS 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2. CAPACITORS VALUES IN μF UNLESS OTHERWISE NOTED
3. INDUCTORS VALUES IN μH UNLESS OTHERWISE NOTED
4. * FACTORY SELECTED VALUE
5. ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-11. 43-MHz Multipliers (CH-A4, 0067)

6.3.12 Main Chassis, CH; 6-db Attenuator, CH-A22; Triplexer, CH-A1; and Oven Assembly, CH-A6



6.3.12 MAIN CHASSIS, CH; TRIPLEXER, CH-A1; 6-db ATTENUATOR, CH-A22 AND OVEN ASSEMBLY, CH-A6

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH	Main Chassis	7000-0005	Cushman
CH-A1	Triplexer Assy	1042-0001	ESL
CH-A6	Crystal Oven Assy	7045-0002	Cushman
CH-A22	6-db Attenuator Assy	7000-0010	Cushman
	CAPACITORS		
C1	Var, glass, 0.5-18 pF	1001-0001	J. F. D.
	COAXIAL, RELAY		
K1	Coaxial, 50Ω 250W, 28V	1313-0003	Dow-Key
	CONNECTORS		
J1	12 Pin Connector	2535-0013	Cinch-Jones
J2	Socket, octal	2605-0001	Elco
J3	24 Pin Connector	2535-0020	Amphenol
J4	24 Pin Connector	2535-0020	Amphenol
J5	B. N. C. Connector	2536-0019	Amphenol
J6	Not Used		
J7	Not Used		
J8	22 Pin Connector	2535-0018	Viking
J9	22 Pin Connector	2535-0018	Viking
J10	22 Pin Connector	2535-0018	Viking
J11	Not Used		
J12	44 Pin Connector	2535-0023	Viking
J13	Not Used		
J14	22 Pin Connector	2535-0018	Viking
J15	22 Pin Connector	2535-0018	Viking
J16	22 Pin Connector	2535-0018	Viking
J17	22 Pin Connector	2535-0018	Viking
J18	22 Pin Connector	2535-0018	Viking
J19	22 Pin Connector	2535-0018	Viking
J20	22 Pin Connector	2535-0018	Viking
	FUSES		
F1	Mdl 2/10 A. Slo. Blo. (Serial No. 455 and up only located under J3 connector)	1955-0009	Bussman

6.3.12 MAIN CHASSIS, CH; TRIPLEXER, CH-A1; 6-db ATTENUATOR, CH-A22 AND OVEN ASSEMBLY, CH-A6 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	FUSEHOLDER		
	Fuse, Clip for F1	3705-0004	Augat
	SPEAKERS		
LS1	3" x 5" Speaker	1715-0003	Quam
	TRANSISTORS		
Q1	Si, NPN, 2N3054	1271-0001	RCA
Q2	Si, NPN, 2N3054	1271-0001	RCA
Q3	Si, NPN, 2N3054	1271-0001	RCA

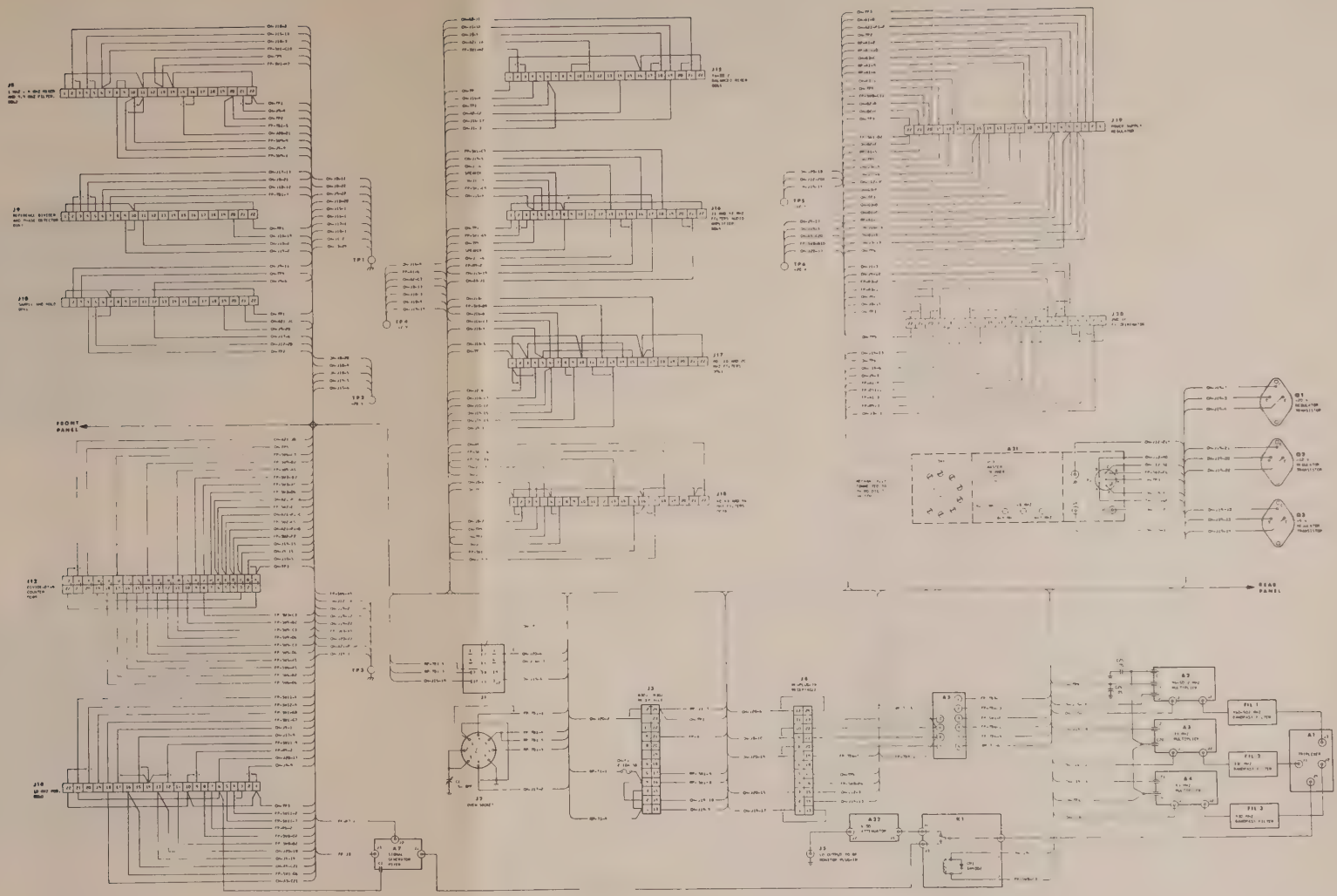
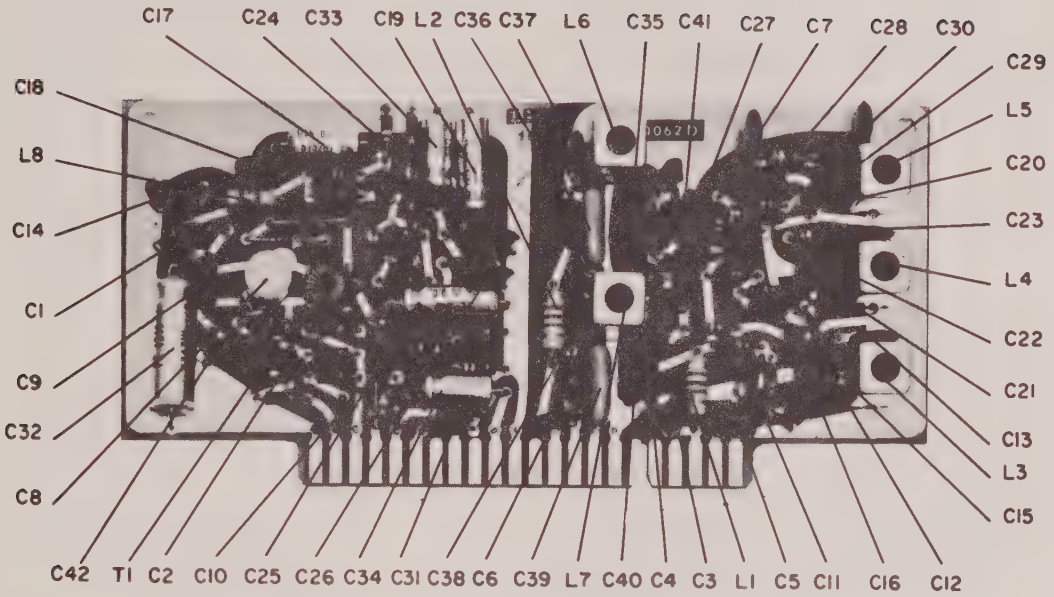
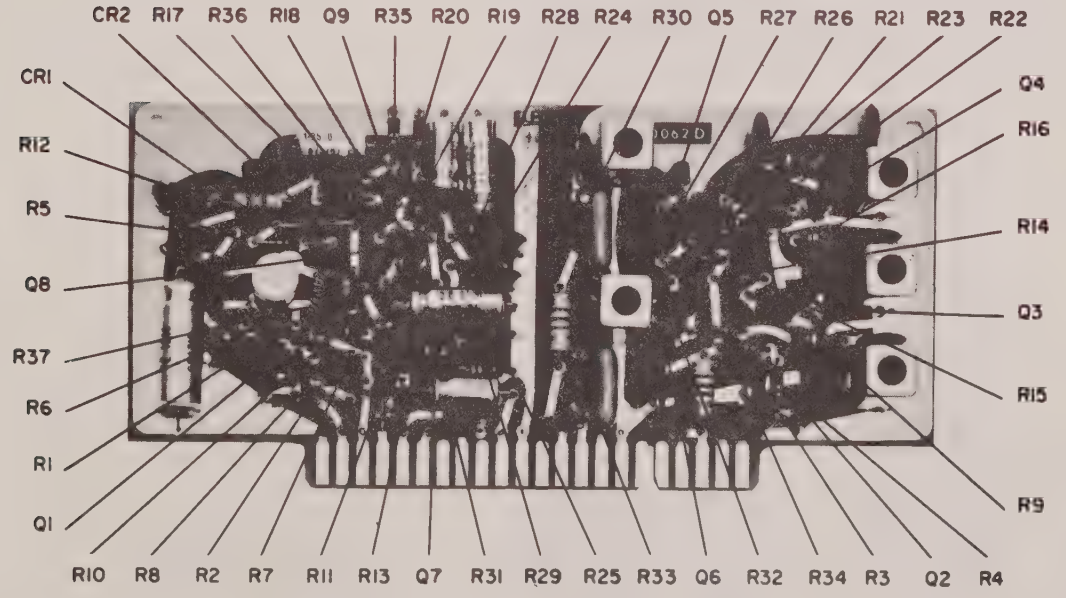


Figure 6-12. Main Chassis Wiring, including:
6-db Attenuator (CH-A22),
Oven Assembly (CH-A6),
Triplexer (CH-A1)

6.3.13 1kHz-to-4MHz and 9.9 MHz Filter, CH-A8





6.3.13 0-TO-4 MHz AND 9.9 MHz MIXERS, CH-A8

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A8	0-to-4 MHz and 9.9 MHz Mixers Board Assy	7000-0062	Cushman
	Printed Circuit Board, Bare	1780-0062	Cushman
	CAPACITORS		
C1	Cer, 0.01 MF +80% -20%, 50V	1005-0013	Erie
C2	Cer, 0.01 MF +80% -20%, 50V	1005-0013	Erie
C3	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C4	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C5	Mica, 560 pF ±5%, 100V	1002-0037	Elmenco
C6	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C7	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C8	Var, Cer, NPO, 9-35 pF	1001-0006	Erie
C9	Mica, 27 pF ±5%, 100V	1002-0008	Elmenco
C10	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C11	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C12	Mica, 510 pF ±5%, 100V	1002-0036	Elmenco
C13	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C14	Mica, 27 pF ±5%, 100V	1002-0008	Elmenco
C15	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C16	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C17	Elect., 1.0 MF +80% -20%, 25V	1013-0004	Sprague
C18	Mica, 27 pF ±5%, 100V	1002-0008	Elmenco
C19	Elect., 15.0 MF +80% -20%, 25V	1013-0005	Sprague
C20	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C21	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C22	Mica, 510 pF ±5%, 100V	1002-0036	Elmenco
C23	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C24	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C25	Elect., 15.0 MF +80% -20%, 25V	1013-0005	Sprague
C26	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C27	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C28	Mica, 12 pF ±5%, 100V	1002-0017	Elmenco
C29	Mica, 510 pF ±5%, 100V	1002-0036	Elmenco
C30	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C31	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C32	Elect., 100 MF +80% -20%, 25V	1013-0003	Sprague
C33	Elect., 1.0 MF +80% -20%, 25V	1013-0004	Sprague
C34	Elect., 1.0 MF +80% -20%, 25V	1013-0004	Sprague
C35	Mica, 620 pF ±5%, 100V	1002-0038	Elmenco

6.3.13 0-TO-4 MHz AND 9.9 MHz MIXERS, CH-A8 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C36	Poly, 0.0082 MF ±10%, 100V	1008-0015	Sprague
C37	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C38	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C39	Poly, 0.0082 MF ±10%, 100V	1008-0015	Sprague
C40	Mica, 430 pF ±5%, 100V	1002-0034	Elmenco
C41	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C42	Cer, 0.01 MF +80% -20%, 50V	1005-0013	Erie
	COILS		
L1	RF Choke, 680 µH ±5%	1585-0023	Delevan
L2	RF Choke, 680 µH ±5%	1585-0023	Delevan
L3	Var Inductor, 2.2-5.1 µH	1596-0004	Cushman
L4	Var Inductor, 2.2-5.1 µH	1596-0004	Cushman
L5	Var Inductor, 2.2-5.1 µH	1596-0004	Cushman
L6	Var Inductor, 2.2-5.1 µH	1596-0004	Cushman
L7	Var Inductor, 0.5-0.75 µH	1596-0011	Cushman
L8	RF Choke, 5.6 µH ±10%	1585-0028	Delevan
	DIODES		
CR1	Ge, G633	1282-0005	ITT
CR2	Ge, G633	1282-0005	ITT
	RESISTORS		
R1	Comp, 27kΩ ±5%, 1/4W	1066-2735	Allen-Bradley
R2	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R3	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R4	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R5	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R6	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R7	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R8	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R9	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R10	Comp, 150Ω ±5%, 1/4W	1066-1515	Allen-Bradley
R11	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R12	Comp, 680Ω ±5%, 1/4W	1066-6815	Allen-Bradley
R13	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R14	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R15	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley

6.3.13 0-TO-4 MHz AND 9.9 MHz MIXERS, CH-A8 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R16	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R17	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R18	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R19	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R20	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R21	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R22	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R23	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R24	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R25	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R26	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R27	Comp, 8.2Ω ±5%, 1/4W	1066-8225	Allen-Bradley
R28	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R29	Comp, 330Ω ±5%, 1/4W	1066-3315	Allen-Bradley
R30	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R31	Comp, 82Ω ±5%, 1/4W	1066-8205	Allen-Bradley
R32	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R33	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R34	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R35	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R36	Comp, 22kΩ ±5%, 1/4W	1066-2235	Allen-Bradley
R37	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
	TRANSFORMERS		
T1	Toroid	1579-0007	Cushman
	TRANSISTORS		
Q1	Si, NPN, 2N3563	1272-0022	Fairchild
Q2	Si, PNP, TIS37	1271-0003	T.I.
Q3	Si, PNP, TIS37	1271-0003	T.I.
Q4	Si, PNP, TIS37	1271-0003	T.I.
Q5	Si, PNP, TIS37	1271-0003	T.I.
Q6	Si, NPN, 2N3563	1272-0022	Fairchild
Q7	Si, NPN, 2N3642	1272-0018	Fairchild
Q8	Si, PNP, 2N4121	1272-0023	Fairchild
Q9	Si, NPN, 2N3563	1272-0022	Fairchild

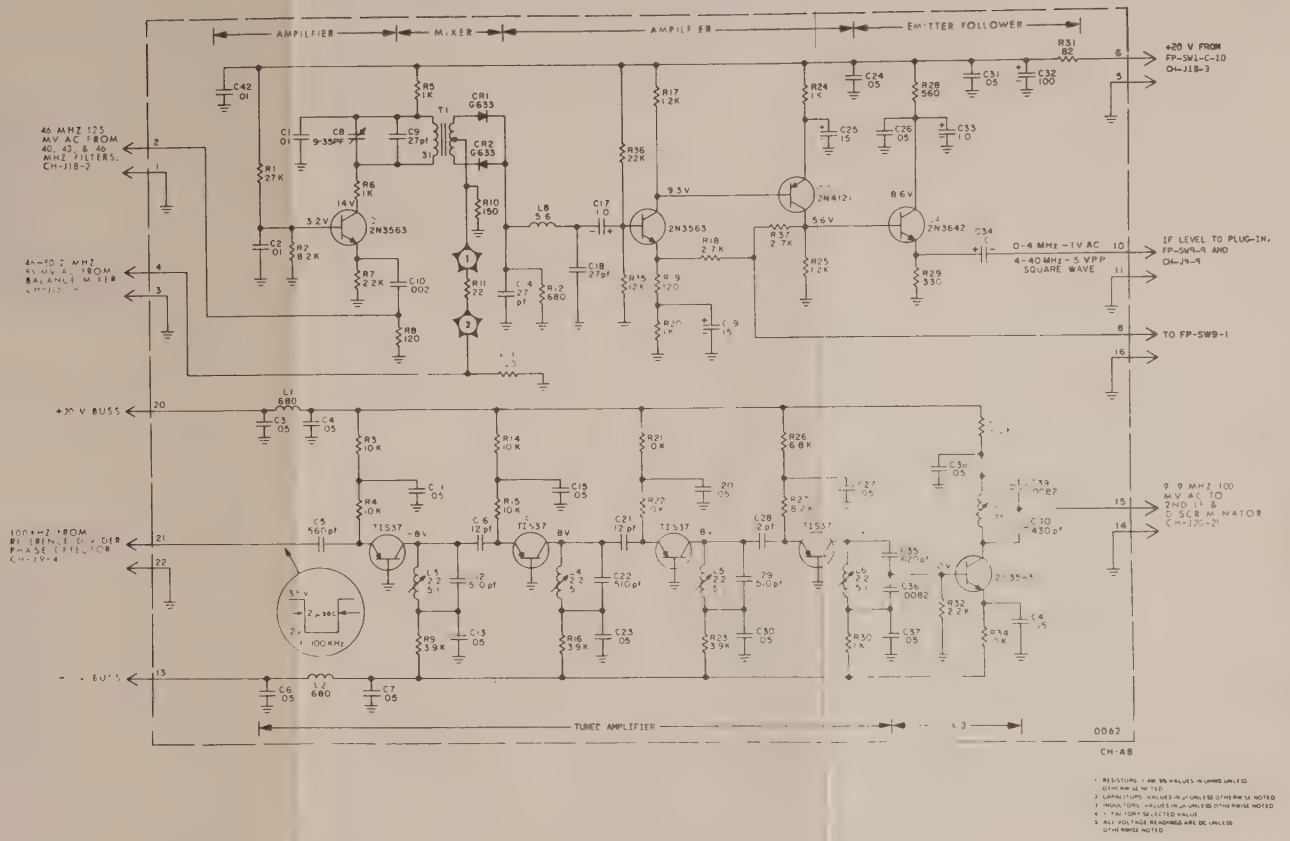
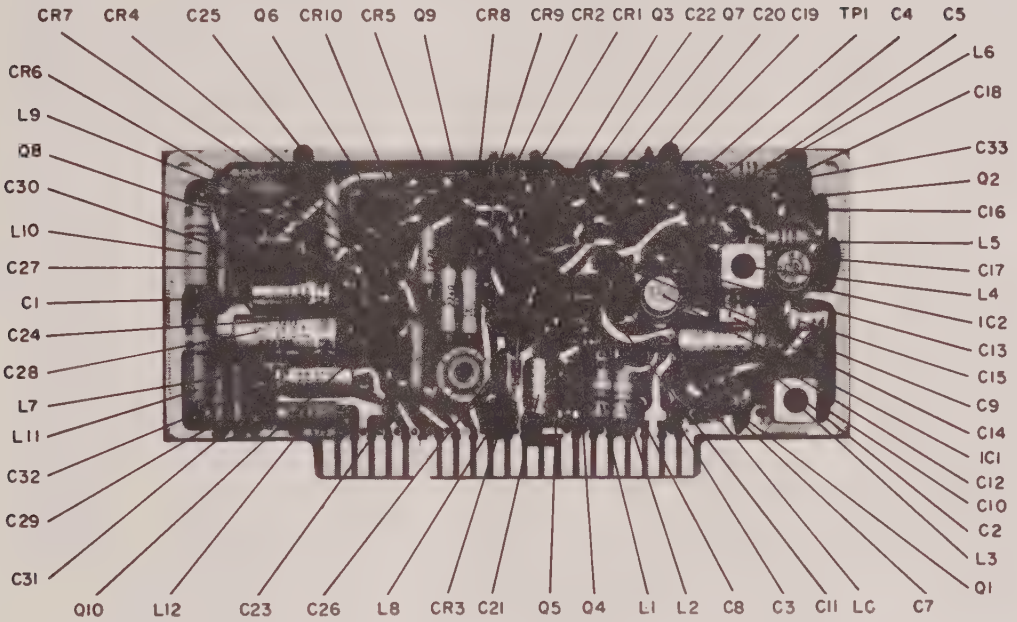
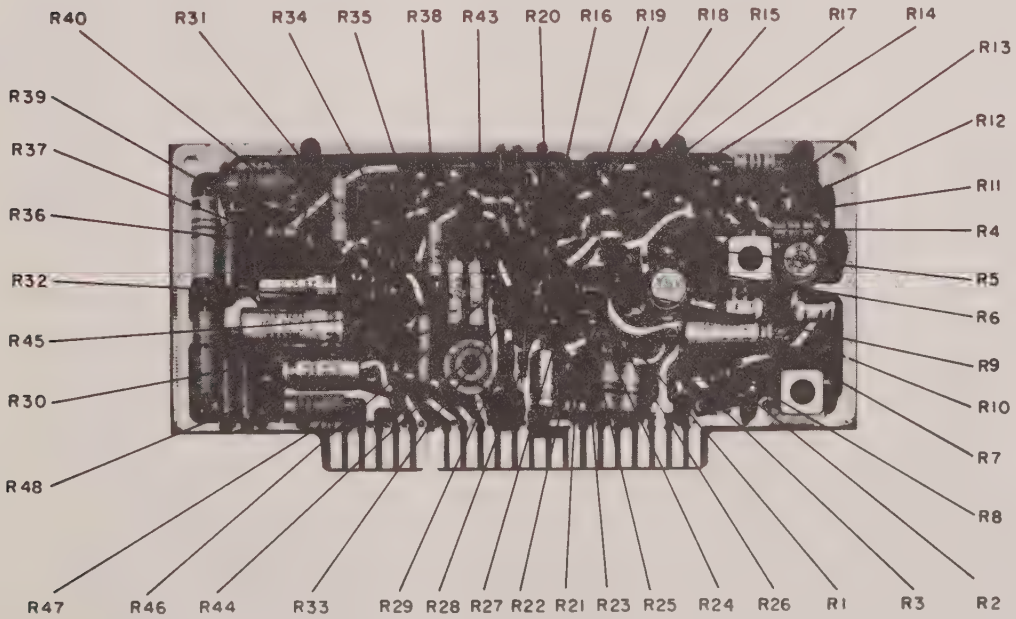


Figure 6-13. 1kHz-to-4MHz Mixer and 9.9-MHz Filter (CH-A8, 0062)

6.3.14 Second IF and Discriminator, CH-A20





6.3.14 SECOND IF AND DISCRIMINATOR CIRCUITS, CH-A20

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A20	Second IF and Discriminator Board Assy	7000-0054	Cushman
	Printed Circuit Board, Bare	1780-0054	Cushman
C1	Elect., 15 MF, 25V	1013-0005	Sprague
C2	Elect., 100 MF, 12V	1013-0011	Sprague
C3	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C4	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C5	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C6	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C7	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C8	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C9	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C10	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C11	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C12	Mica, 430 pF ±5%, 100V	1002-0034	Elmenco
C13	Mica, 430 pF ±5%, 100V	1002-0034	Elmenco
C14	Cer, 3.3 pF ±0.25 pF, 500V	1005-0011	Erie
C15	Cer, 2.2 pF ±0.25 pF, 500V	1005-0017	Erie
C16	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C17	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C18	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C19	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C20	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C21	Elect., 15 MF, 12V	1013-0015	Sprague
C22	Mica, 100 pF ±5%, 100V	1002-0011	Elmenco
C23	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C24	Mica, 470 pF ±1%, 100V	1002-0044	Elmenco
C25	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C26	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C27	Poly, 0.027 MF ±10%, 100V	1008-0032	Sprague
C28	Elect., 100 MF, 25V	1013-0003	Sprague
C29	Poly, 0.027 MF ±10%, 100V	1008-0032	Sprague
C30	Mica, 2000 pF ±5%, 100V	1002-0077	Elmenco
C31	Poly, 0.027 MF ±10%, 100V	1008-0032	Sprague
C32	Elect., 15 MF, 25V	1013-0005	Sprague
C33	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie

6.3.14 SECOND IF AND DISCRIMINATOR CIRCUITS, CH-A20 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R11	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R12	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R13	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R14	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R15	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R16	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R17	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R18	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R19	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R20	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R21	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R22	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R23	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R24	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R25	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R26	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R27	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R28	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R29	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R30	M Film, 1kΩ ±1%, 3/4W	1076-0007	Electra
R31	M Film, 357Ω ±1%, 3/4W	1076-0012	Electra
R32	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
R33	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
R34	Comp, 1.2kΩ ±5%, 1/2W	1067-1225	Allen-Bradley
R35	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R36	M Film, 2.21kΩ ±1%, 1/4W	1075-0010	Electra
R37	M Film, 10kΩ ±1%, 1/4W	1075-0009	Electra
R38	M Film, 14.7kΩ ±1%, 1/2W	1076-0011	Electra
R39	M Film, 332Ω ±1%, 1/4W	1075-0024	Electra
R40	M Film, 2.21kΩ ±1%, 1/4W	1075-0010	Electra
R41	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley
R42	Comp, 33kΩ ±5%, 1/4W	1066-3335	Allen-Bradley
R43	M Film, 1kΩ ±1%, 3/4W	1076-0007	Electra
R44	Pot., comp, 200Ω, 1/4W	1200-0016	Allen-Bradley
R45	M Film 274Ω ±1%, 3/4W	1076-0013	Electra
R46	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R47	M Film, 475Ω ±1%, 1/4W	1075-0023	Electra
R48	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley

6.3.14 SECOND IF AND DISCRIMINATOR CIRCUITS, CH-A20 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	COILS		
L1	RF Choke, 470 µH ±5%	1585-0019	Delevan
L2	RF Choke, 470 µH ±5%	1585-0019	Delevan
L3	Var Inductor, 0.5-0.75 µH	1596-0011	TRW
L4	Var Inductor, 0.5-0.75 µH	1596-0011	TRW
L5	RF Choke, 82 µH ±5%	1585-0032	Delevan
L6	RF Choke, 82 µH ±5%	1585-0032	Delevan
L7	RF Choke, 22 mH	1585-0029	Delevan
L8	RF Choke, 22 mH	1585-0029	Delevan
L9	RF Choke, 2.2 mH ±5%	1585-0030	Delevan
L10	RF Choke, 4.7 mH ±5%	1585-0006	Delevan
	DIODES		
CR1	Ge, G633	1282-0005	ITT
CR2	Ge, G633	1282-0005	ITT
CR3	Ge, G633	1282-0005	ITT
CR4	Si, 1N3064	1281-0013	Sylvania
CR5	Si, 1N3064	1281-0013	Sylvania
CR6	Si, 1N3064	1281-0013	Sylvania
CR7	Si, 1N3064	1281-0013	Sylvania
CR8	Si, 1N3064	1281-0013	Sylvania
CR9	Ge, G633	1282-0005	ITT
CR10	Si, 1N3064	1281-0013	Sylvania
	INTEGRATED CIRCUITS		
IC1	RF Ampl, CA3028A	2025-0012	RCA
IC2	RF Ampl, CA3028A	2025-0012	RCA
	RESISTORS		
R1	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R2	Comp, 2.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley
R3	Comp, 3.3kΩ ±5%, 1/4W	1066-3325	Allen-Bradley
R4	Comp, 220Ω ±5%, 1/2W	1067-2215	Allen-Bradley
R5	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
R6	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R7	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R8	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R9	Comp, 51Ω ±5%, 1/4W	1066-5105	Allen-Bradley
R10	Comp, 3.9kΩ ±5%, 1/4W	1066-3925	Allen-Bradley

6.3.14 SECOND IF AND DISCRIMINATOR CIRCUITS, CH-A20 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	TRANSISTORS		
Q1	Si, PNP, TIS37	1271-0003	T.I.
Q2	Si, NPN, 2N3565	1272-0017	Fairchild
Q3	Si, NPN, 2N4275	1272-0016	Fairchild
Q4	Si, NPN, 2N3565	1272-0017	Fairchild
Q5	Si, NPN, 2N3565	1272-0017	Fairchild
Q6	Si, NPN, 2N4275	1272-0016	Fairchild
Q7	Si, NPN, 2N3567	1272-0014	Fairchild
Q8	Si, NPN, 2N3565	1272-0017	Fairchild
Q9	Si, NPN, 2N4275	1272-0016	Fairchild
Q10	Si, NPN, 2N3565	1272-0017	Fairchild

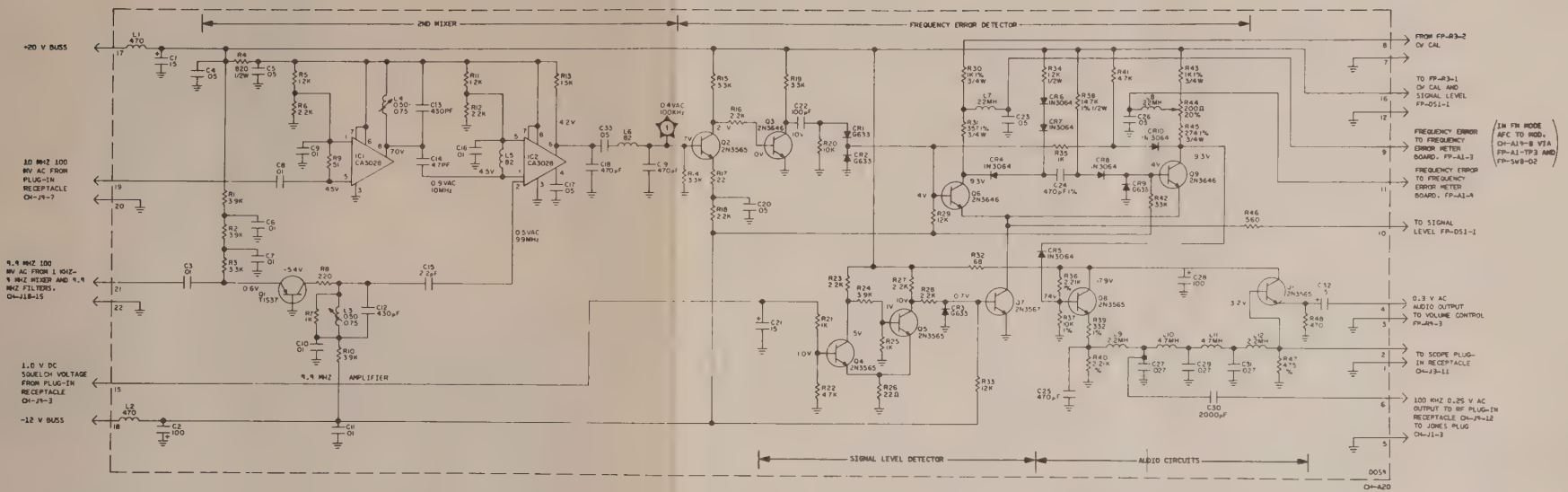
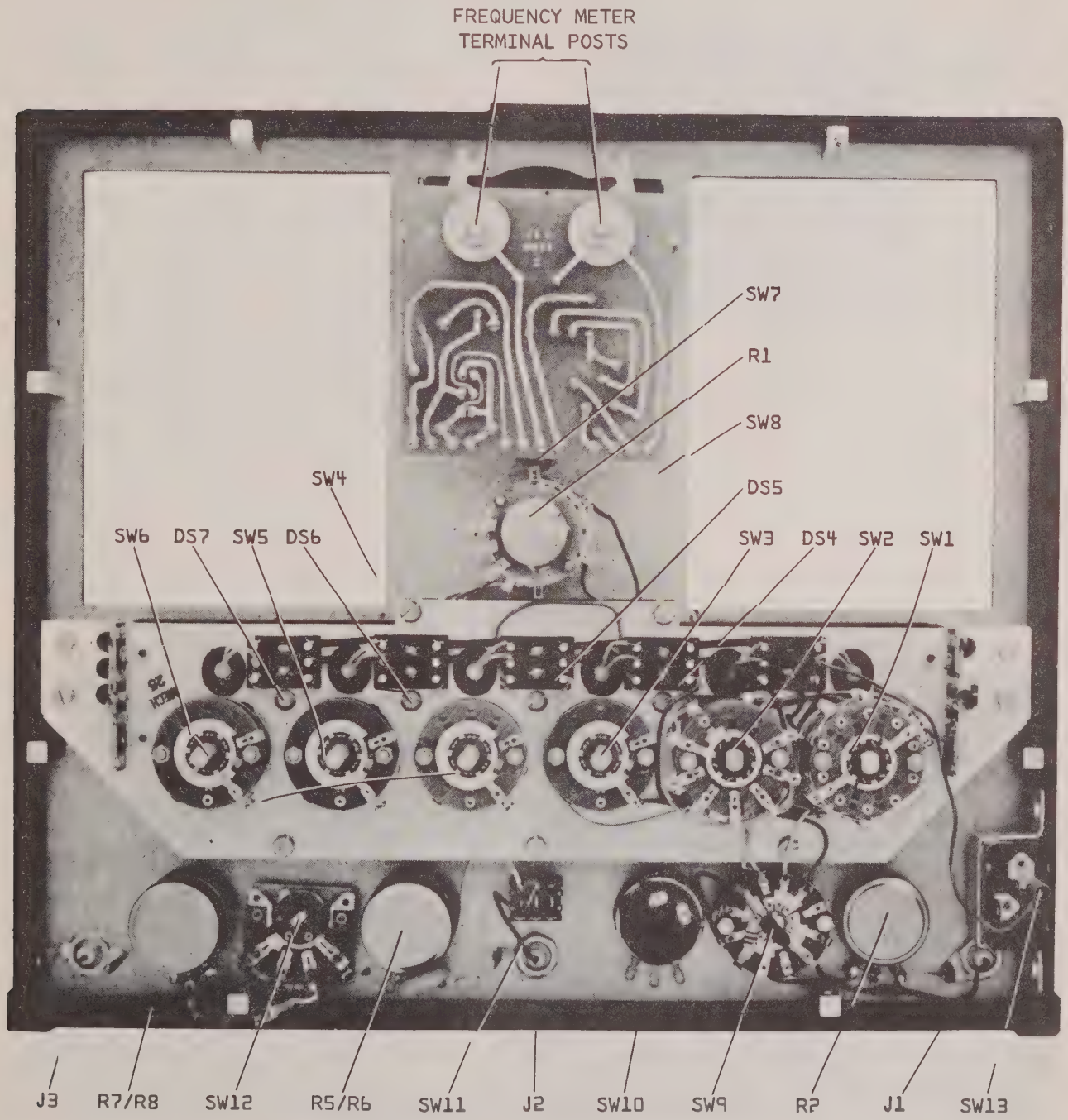
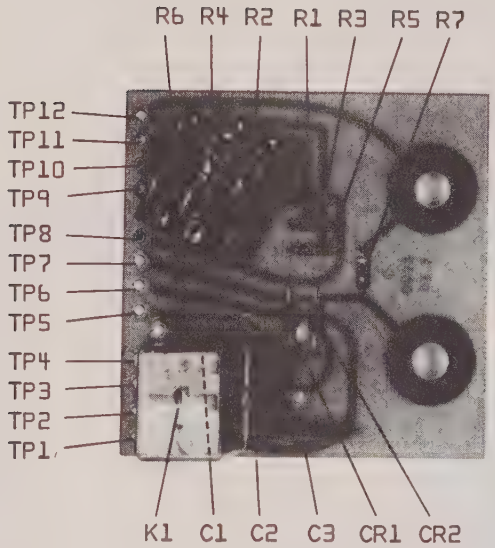

2ND MIXER
FREQUENCY ERROR DETECTOR
SIGNAL LEVEL DETECTOR
AUDIO CIRCUITS
+20 V BUSS
-12 V BUSS
10 MHZ 100 MV AC FROM PLUG-IN RECEPTACLE CH-J9-7
9.9 MHZ 100 MV AC FROM 1 KHZ-9 MHZ MIXER AND 9.9 MHZ FILTERS. CH-J18-15
1.0 V DC SQUELCH VOLTAGE FROM PLUG-IN RECEPTACLE CH-J9-3
9.9 MHZ AMPLIFIER
FROM FP-A3-2 CW CAL
TO FP-A3-1 CW CAL AND SIGNAL LEVEL FP-D51-1
FREQUENCY ERROR TO FREQUENCY ERROR METER BOARD. FP-A1-3
FREQUENCY ERROR TO FREQUENCY ERROR METER BOARD. FP-A1-4
TO SIGNAL LEVEL FP-D51-1
0.3 V AC AUDIO OUTPUT TO VOLUME CONTROL FP-A9-3
TO SCOPE PLUG-IN RECEPTACLE CH-J3-11
100 KHZ 0.25 V AC OUTPUT TO RF PLUG-IN RECEPTACLE CH-J9-12 TO JONES PLUG CH-J1-3
(IN FM MODE AFC TO MOD. CH-A19-8 VIA FP-A1-TP3 AND FP-SW8-D2)
0054
CH-A20

Figure 6-14. Second-IF and Discriminator Circuits (CH-A20, 0054)

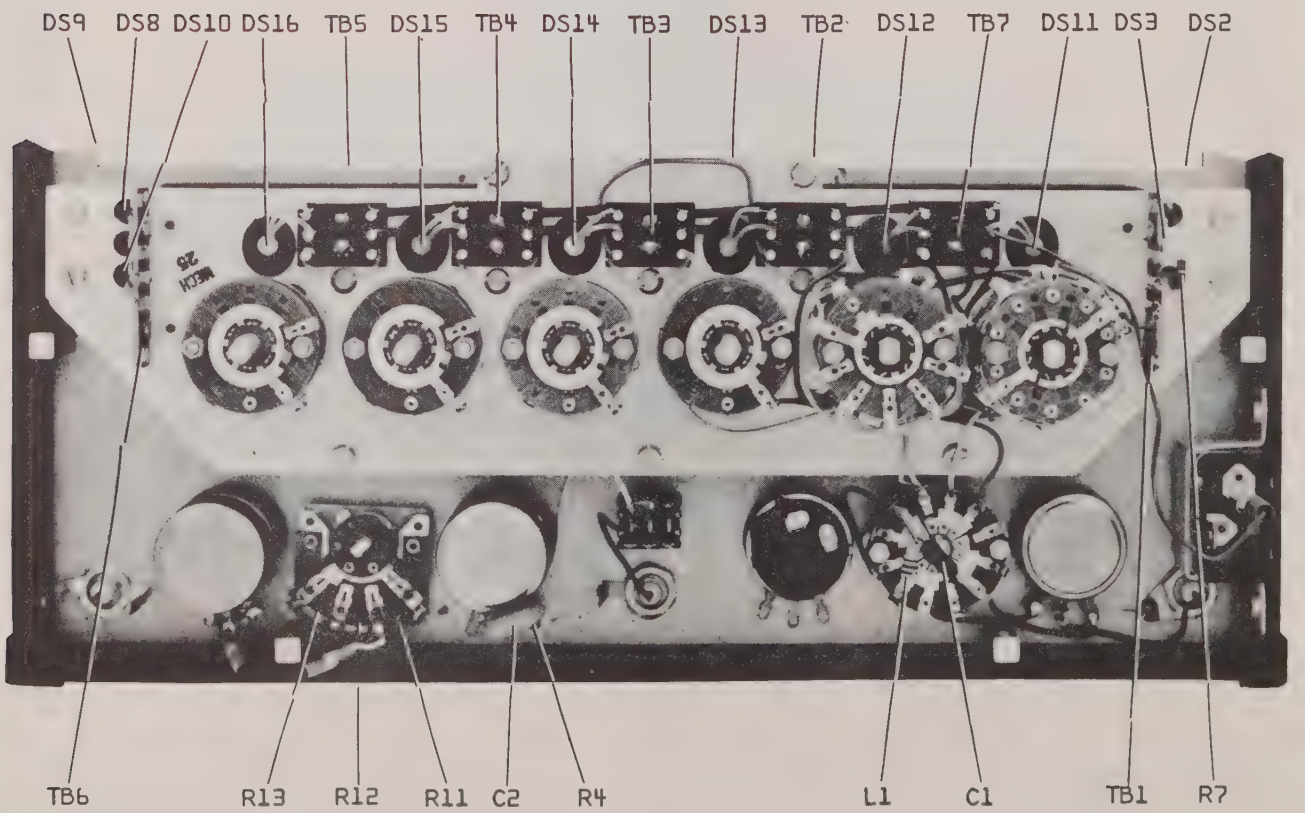
6.3.15 Front Panel, FP; and Frequency-Error Meter Board, FP-A1





6.3.15 FRONT PANEL, FP, AND FREQUENCY-ERROR METER BOARD, FP-A1

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
FP	Front Panel Assy	7000-0003	Cushman
	CAPACITORS		
C1	Cer, 0.1 MF +80% -30%, 75V	1005-0019	Centralab
	KNOBS		
	CW Cal (R3)	2780-0009	Kurz-Kasch
	FM Cal (R6)	2780-0009	Kurz-Kasch
	Function (SW8)	2780-0007	Kurz-Kasch
	Dev Adj (R5)	2780-0007	Kurz-Kasch
	IF Level (R2)	2780-0007	Kurz-Kasch
	IF Sel (SW9)	2780-0015	Kurz-Kasch
	ON-OFF (SW10, R4)	2780-0015	Kurz-Kasch
	Sig Gen Attenuator, Microvolts (R7, R8)	2780-0015	Kurz-Kasch
	Sig Gen Attenuator, X1, X10, X100 (SW12)	2780-0015	Kurz-Kasch
	Frequency Selectors (SW1 through SW6)	2780-0016	Kurz-Kasch
	Meter-Range Switch (SW7)	2780-0021	Kurz-Kasch
	LAMPS		
DS1	Incandescent Cartridge, 10V, 14 ma	2870-0010	Dialco
DS2	Ne	2871-0001	G. E.
DS3	Incandescent, #7330	2870-0011	IEE
DS4	Incandescent, #7330	2870-0011	IEE
DS5	Incandescent, #7330	2870-0011	IEE
DS6	Incandescent, #7330	2870-0011	IEE
DS7	Incandescent, #7330	2870-0011	IEE
DS8	Incandescent, #7330	2870-0011	IEE
DS9	Incandescent, #7330	2870-0011	IEE
DS10	Incandescent, #7330	2870-0011	IEE
DS11	Incandescent, #7330	2870-0011	IEE
DS12	Incandescent, #7330	2870-0011	IEE
DS13	Incandescent, #7330	2870-0011	IEE
DS14	Incandescent, #7330	2870-0011	IEE
DS15	Incandescent, #7330	2870-0011	IEE
DS16	Incandescent, #7330	2870-0011	IEE



6.3.15 FRONT PANEL, FP, AND FREQUENCY-ERROR METER BOARD, FP-A1 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	RESISTORS		
R1	Comp, 68kΩ ±5%, 1/4W	1066-6835	Allen-Bradley
R2	Pot., comp, lin, 250Ω, 2W	1203-0019	Allen-Bradley
R3	Pot., comp, lin, 10kΩ, 2W	p/o1203-0018	Allen-Bradley
R4	Comp, 470kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R5	Pot., comp, log, 1kΩ, 2W	p/o1204-0003	Allen-Bradley
R6	Pot., comp, lin, 0.5mΩ, 2W	p/o1204-0003	Allen-Bradley
R7	Pot., comp, lin, 50Ω, 2W	p/o1204-0004	Allen-Bradley
R8	Pot., comp, lin, 3kΩ, 2W	p/o1204-0004	Allen-Bradley
R9	M Film, 121Ω ±1%, 1/10W	1075-0006	Electra
R10	M Film, 61.9Ω ±1%, 1/10W	1075-0007	Electra
R11	M Film, 499Ω ±1%, 1/10W	1075-0008	Electra
R12	M Film, 54.9Ω ±1%, 1/10W	1075-0005	Electra
R13	M Film, 499Ω ±1%, 1/10W	1075-0008	Electra
R14	Pot., comp, lin, 100Ω, 2W	p/o1851-0020	Allen-Bradley
	SWITCHES		
SW1	Rotary, special, first digit	1851-0020	Marco-Oak
SW2	Rotary, special, second digit	1851-0021	Marco-Oak
SW3	Rotary, special, third-sixth digit	1851-0027	Marco-Oak
SW4	Rotary, special, third-sixth digit	1851-0027	Marco-Oak
SW5	Rotary, special, third-sixth digit	1851-0027	Marco-Oak
SW6	Rotary, special, third-sixth digit	1851-0027	Marco-Oak
SW7	Lever, 2P3 pos, range	1351-0016	Centralab
SW8	Rotary, special, function	1851-0025	CTS
SW9	Rotary, 4P2 pos, IF range	1851-0022	Centralab
SW10	On-Off	p/o1203-0018	Allen-Bradley
SW11	Toggle, 3P2 pos, FM mod	1850-0007	Alco
SW12	Rotary, 1P3 pos, sig gen atten	1851-0001	CRL
SW13	Flasher	1313-0004	Signal-Stat
FP-A1	Frequency-Error Meter Board Assy	7000-0052	Cushman
M1	Frequency-Error Meter	1402-0018	Cushman
	Printed Circuit Board, Bare	1780-0052	Cushman
	CAPACITORS		
C1	Cer, 0.1 MF +80% -30%, 75V	1005-0019	Centralab

6.3.15 FRONT PANEL, FP, AND FREQUENCY-ERROR METER BOARD, FP-A1 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	DIODES		
CR1	Si, 1N816	1281-0009	Sylvania
CR2	Si, 1N816	1281-0009	Sylvania
	RELAYS		
K1	12 VDC, DPDT	1313-0002	Guardian
	RESISTORS		
R1	Comp, 27kΩ ±5%, 1/4W	1066-2735	Allen-Bradley
R2	Pot., WW, 10kΩ, 1/2W	1215-0005	Helitrim
R3	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R4	Pot., WW, 5kΩ, 1/2W	1215-0003	Helitrim
R5	Comp, 33Ω ±5%, 1/4W	1066-3305	Allen-Bradley
R6	Pot., WW, 1kΩ, 1/2W	1215-0004	Helitrim
R7	Comp, 4.7kΩ ±5%, 1/4W	1066-4725	Allen-Bradley

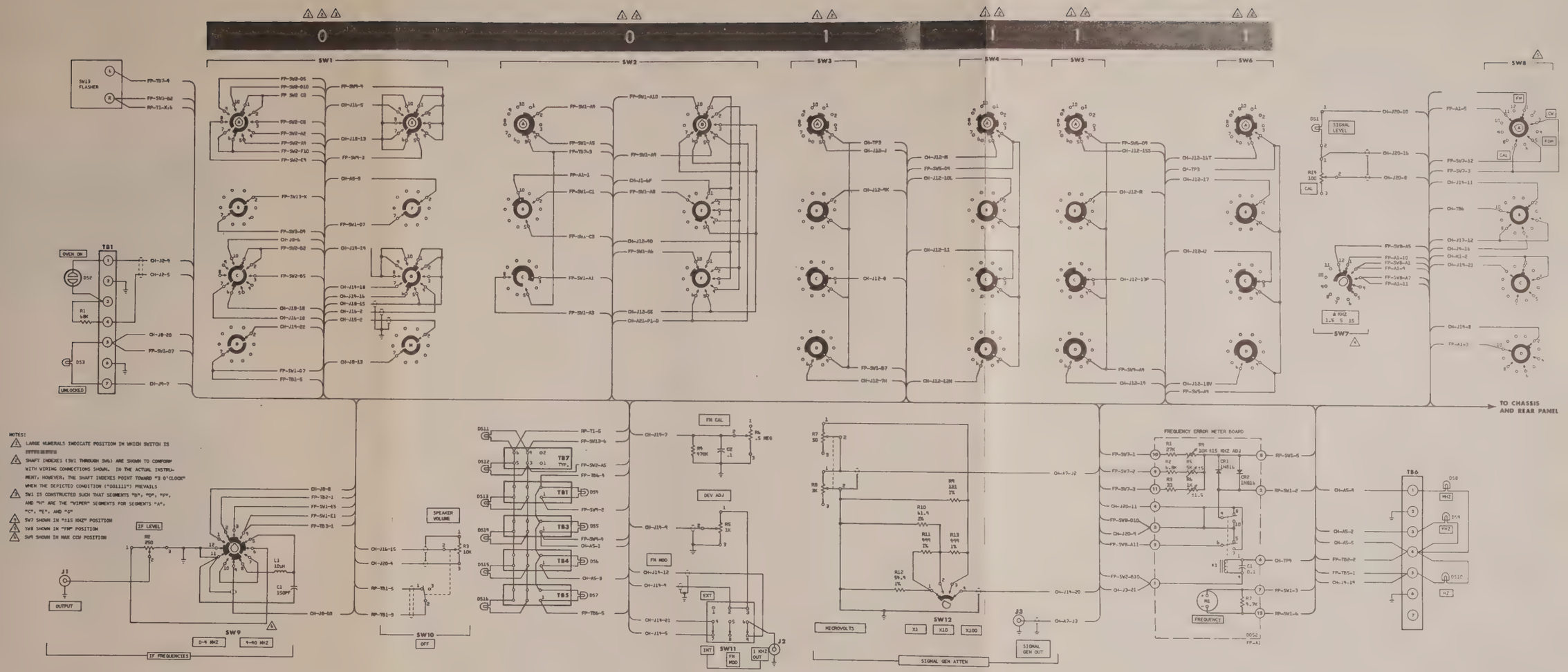
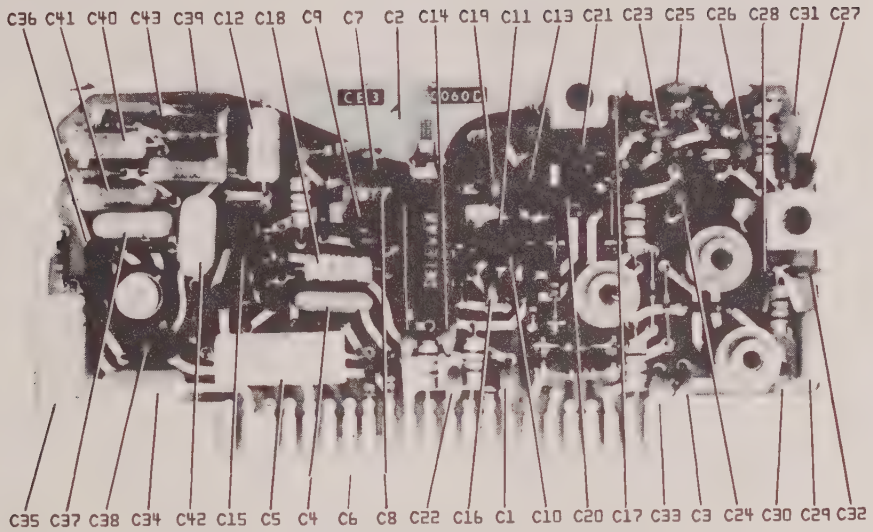
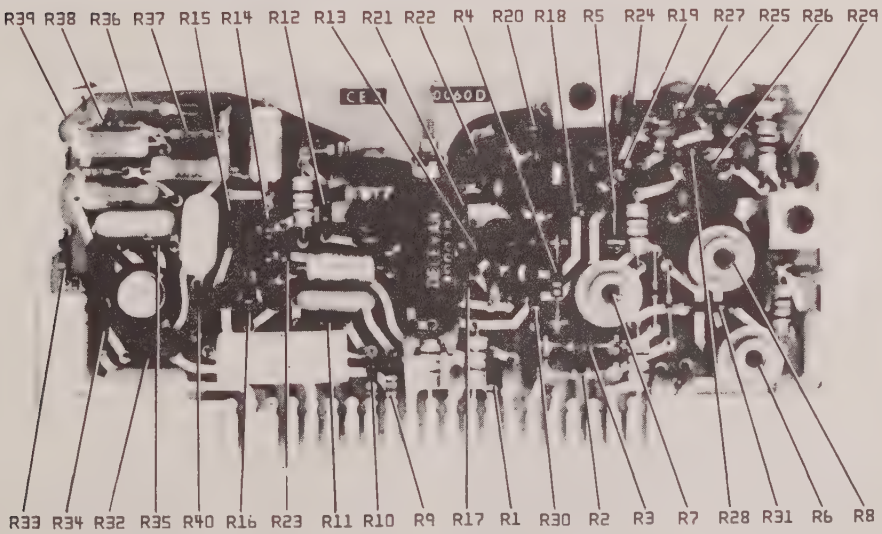
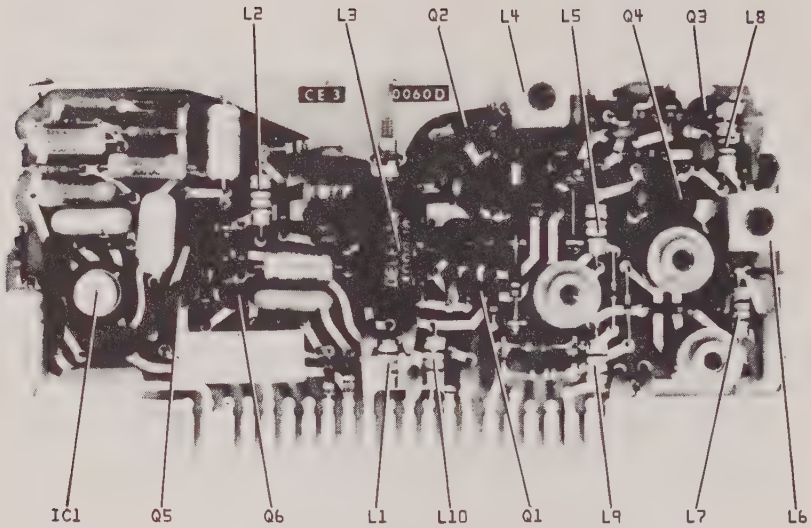


Figure 6-15. Frequency-Error-Meter Board (FP-A1, 0052) and Front Panel Wiring

6.3.16 10-MHz Modulator, CH-A14







6.3.16 10-MHz MODULATOR, CH-A14

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A14	10-MHz Modulator Board Assy	7000-0060	Cushman
	Printed Circuit Board, Bare	1780-0060	Cushman
	CAPACITORS		
C1	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C2	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C3	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C4	Poly, 0.027 MF ±10%, 100V	1008-0032	Sprague
C5	Metalized Mylar, 1.0 MF ±10%, 100V	1008-0033	Good-All
C6	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C7	Mica, 180 pF &5%, 100V	1002-0005	Elmenco
C8	Cer, 22 pF ±2%, 600V, N750	1005-0007	Centralab
C9	Mica, 22 pF ±5%, 100V	1002-0023	Elmenco
C10	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C11	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C12	Elect., 1 MF, 25V	1013-0004	Sprague
C13	Mica, 15 pF ±5%, 100V	1002-0001	Elmenco
C14	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C15	Mica, 180 pF ±5%, 100V	1002-0005	Elmenco
C16	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C17	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C18	Elect., 1 MF, 25V	1013-0004	Sprague
C19	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C20	Mica, 39 pF ±5%, 100V	1002-0018	Elemenco
C21	Mica, 390 pF ±5%, 100V	1002-0033	Elmenco
C22	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C23	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C24	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C25	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C26	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C27	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C28	Mica, 470 pF ±5%, 100V	1002-0035	Elmenco
C29	Poly, 0.0033 MF ±10%, 100V	1008-0041	Sprague
C30	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C31	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C32	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C33	Cer, 0.01 MF +80% -20%, 25V	1005-0013	Erie
C34	Poly, 0.1 MF ±10%, 100V	1008-0031	Sprague
C35	Elect., 25MF, 25V	1013-0010	Sprague

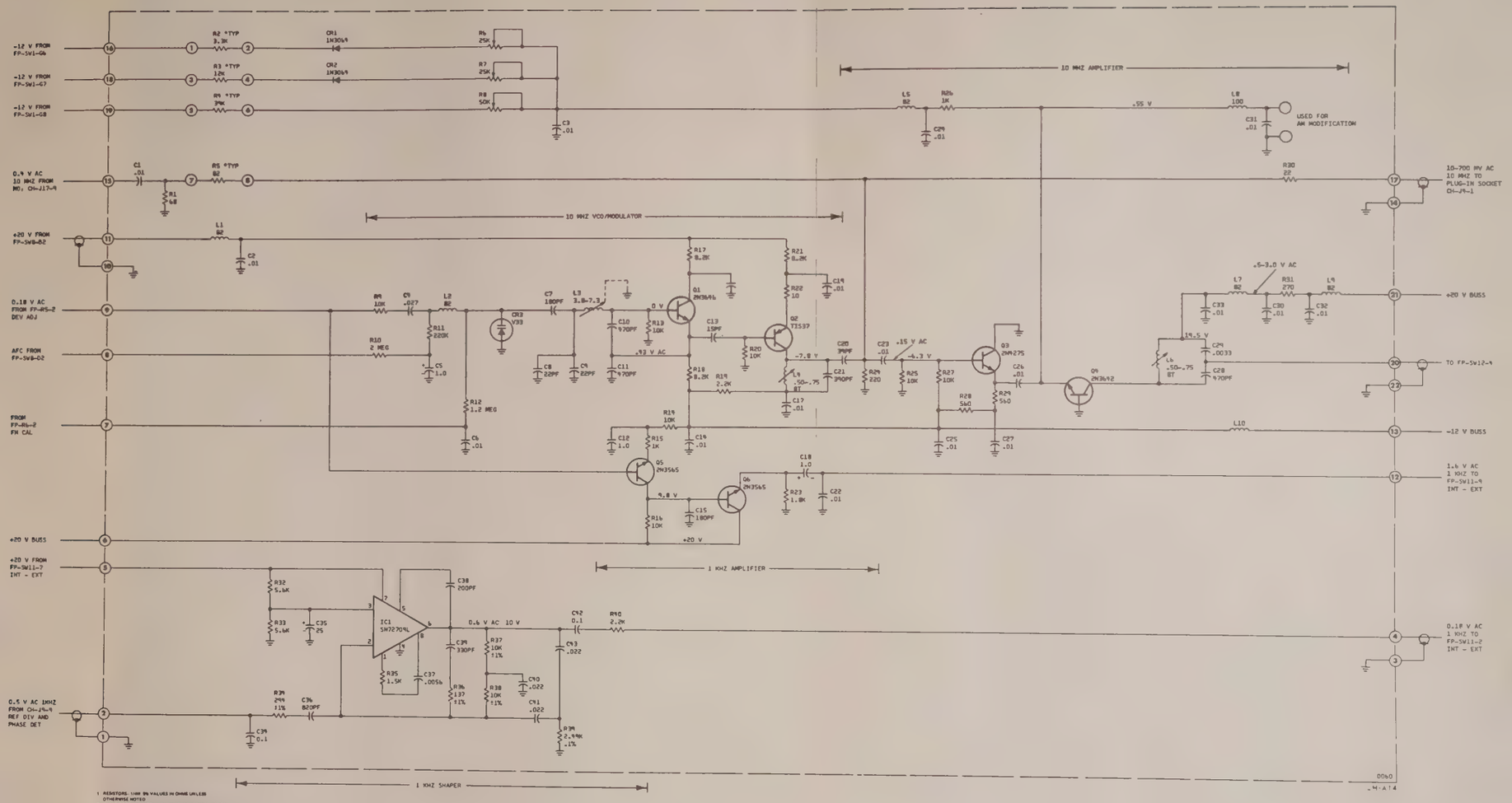
6.3.16 10-MHZ MODULATOR, CH-A14 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
C36	Mica, 820 pF ±5%, 100V	1002-0039	Elmenco
C37	Poly, 0.0056 ±10%, 100V	1008-0022	Sprague
C38	Mica, 200 pF ±5%, 100V	1002-0042	Elmenco
C39	Mica, 330 pF ±5%, 100V	1002-0032	Elmenco
C40	Poly, 0.022 MF ±5%, 200V	1008-0010	Sprague
C41	Poly, 0.022 MF ±5%, 200V	1008-0010	Sprague
C42	Poly, 0.1 MF ±10%, 100V	1008-0031	Sprague
C43	Poly, 0.022 MF ±5%, 200V	1008-0010	Sprague
	COILS		
L1	RF Choke, 82 µH ±5%	1585-0032	Delevan
L2	RF Choke, 82 µH ±5%	1585-0032	Delevan
L3	Var Inductor, 3.8-7.2 µH	1596-0025	Delevan
L4	Var Inductor, 0.5-0.75 µH	1596-0011	TRW
L5	RF Choke, 82 µH ±5%	1585-0032	Delevan
L6	Var Inductor, 0.5-0.75 µH	1596-0011	TRW
L7	RF Choke, 82 µH ±5%	1585-0032	Delevan
L8	RF Choke, 100 µH ±5%	1585-0026	
L9	RF Choke, 82 µH ±5%	1585-0032	Delevan
L10	RF Choke, 82 µH ±5%	1585-0032	Delevan
	DIODES		
CR1	Si, 1N3064	1281-0013	Sylvania
CR2	Si, 1N3064	1281-0013	Sylvania
CR3	Voltage Var, C Diode, V33	1281-0010	TRW
	INTEGRATED CIRCUITS		
IC1	SN72709L	2025-0014	Fairchild
	RESISTORS		
R1	Comp, 68Ω ±5%, 1/4W	1066-6805	Allen-Bradley
*R2	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
*R3	Comp, 6.8Ω ±5%, 1/4W	1066-0004	Allen-Bradley
*R4	Comp, 12kΩ ±5%, 1/4W	1066-1235	Allen-Bradley
*R5	Comp, 82Ω ±5%, 1/4W	1066-8205	Allen-Bradley
R6	Var, 10k, 1/4W	1200-0013	Allen-Bradley
R7	Var, 10k, 1/4W	1200-0013	Allen-Bradley
R8	Var, 25k, 1/4W	1200-0014	Allen-Bradley
R9	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R10	Comp, 2MΩ ±5%, 1/4W	1066-2055	Allen-Bradley

*Factory selected value, typical value shown.

6.3.16 10-MHz MODULATOR, CH-A14 (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R11	Comp, 220kΩ ±5%, 1/4W	1066-2245	Allen-Bradley
R12	Comp, 1.2MΩ ±5%, 1/4W	1066-1255	Allen-Bradley
R13	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R14	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R15	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R16	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R17	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R18	Comp, 8.2kΩ ±5%, 1/4W	1066-8225	Allen-Bradley
R19	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
R20	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R21	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R22	Comp, 100Ω ±5%, 1/4W	1066-1015	Allen-Bradley
R23	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley
R24	Comp, 220Ω ±5%, 1/4W	1066-2215	Allen-Bradley
R25	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R26	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R27	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R28	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R29	Comp, 560Ω ±5%, 1/4W	1066-5615	Allen-Bradley
R30	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R31	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R32	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R33	Comp, 5.6kΩ ±5%, 1/4W	1066-5625	Allen-Bradley
R34	M Film, 294kΩ ±1%, 1/4W	1073-0028	Electra
R35	Comp, 1.5kΩ ±5%, 1/4W	1066-1525	Allen-Bradley
R36	M Film, 137Ω ±1%, 1/4W	1075-0026	Electra
R37	M Film, 10kΩ ±1%, 1/4W	1075-0009	Electra
R38	M Film, 10kΩ ±1%, 1/4W	1073-0009	Electra
R39	M Film, 2.49kΩ ±1%, 1/4W	1073-0027	Electra
R40	Comp, 2.2kΩ ±5%, 1/4W	1066-2225	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N4275	1272-0016	Fairchild
Q2	Si, PNP, TIS37	1271-0003	T.I.
Q3	Si, NPN, 2N4275	1272-0016	Fairchild
Q4	Si, NPN, 2N3642	1272-0018	Fairchild
Q5	Si, NPN, 2N3565	1272-0017	Fairchild
Q6	Si, NPN, 2N3565	1272-0017	Fairchild

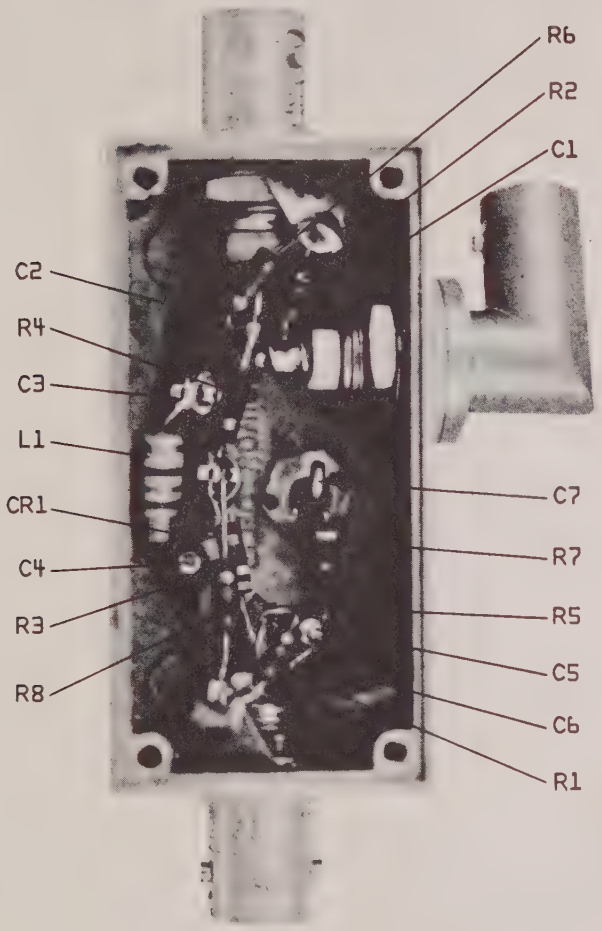


1 RESISTORS: 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2 CAPACITORS: VALUES IN μf UNLESS OTHERWISE NOTED
3 INDUCTORS: VALUES IN μh UNLESS OTHERWISE NOTED
4 * - FACTORY SELECTED VALUE
5 ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

5601**0095

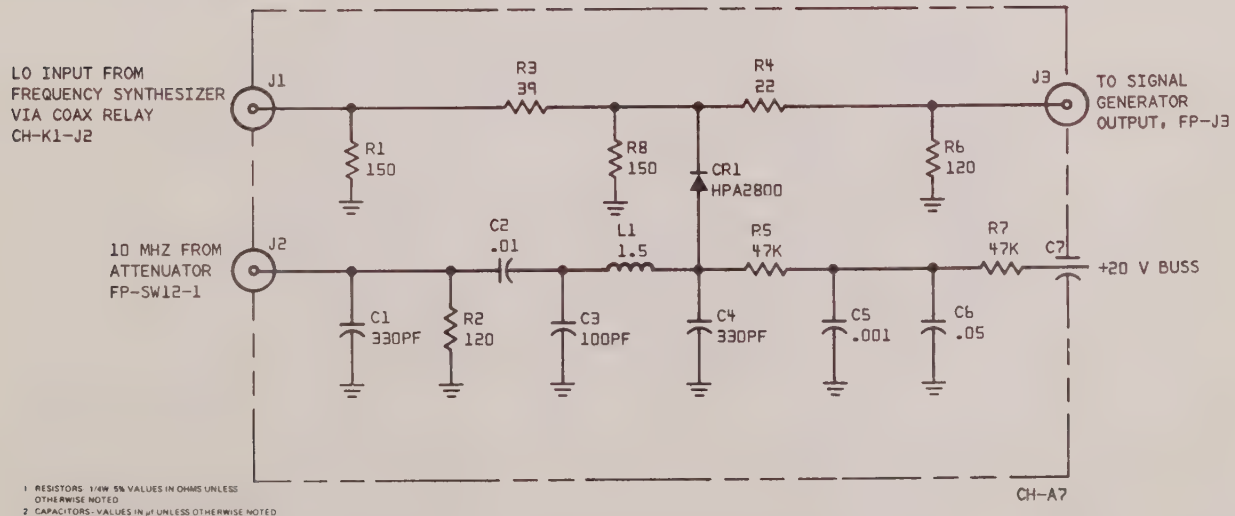
Figure 6-16. 10-MHz Modulator (CH-A14, 0060)

6.3.17 Signal Generator Mixer, CH-A7



6.3.17 SIGNAL GENERATOR CH-A7

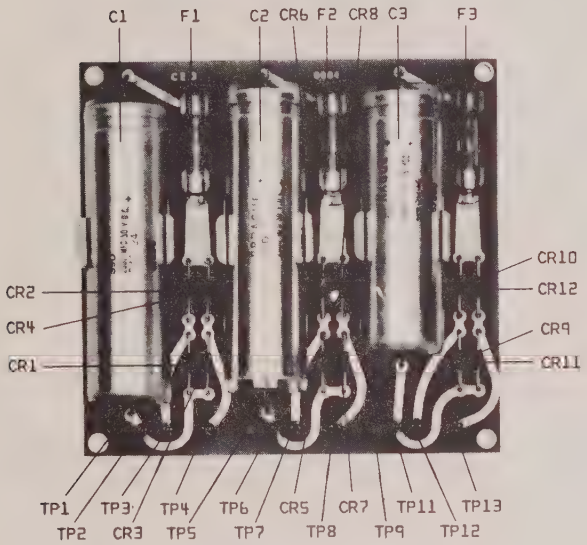
CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A7	Signal Generator Assy	7040-0026	Cushman
	CAPACITORS		
C1	Mica, 330 pF ±5%, 100V	1002-0032	Elmenco
C2	Cer, 0.01 MF +80% -20%, 50V	1005-0013	Erie
C3	Not Used		
C4	Cer, Stand Off, 330 pF, GMV, 500V	1005-0050	Erie
C5	Cer, Stand Off, 0.001 MF, GMV, 500V	1005-0048	Erie
C6	Cer, 0.05 MF +80% -20%, 25V	1005-0014	Erie
C7	Cer, Feedthru, 0.001 MF ±20%, 500V	1005-0008	Erie
	COILS		
L1	RF Choke, 1.5 µH ±20%	1585-0038	Delevan
	DIODES		
CR1	Si, 2800	1283-0001	HPA
	RESISTORS		
R1	Comp, 150Ω ±5%, 1/4W	1066-1515	Allen-Bradley
R2	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R3	Comp, 39Ω ±5%, 1/4W	1066-3905	Allen-Bradley
R4	Comp, 22Ω ±5%, 1/4W	1066-2205	Allen-Bradley
R5	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R6	Comp, 120Ω ±5%, 1/4W	1066-1215	Allen-Bradley
R7	Comp, 47kΩ ±5%, 1/4W	1066-4735	Allen-Bradley
R8	Comp, 150Ω ±5%, 1/4W	1066-1515	Allen-Bradley

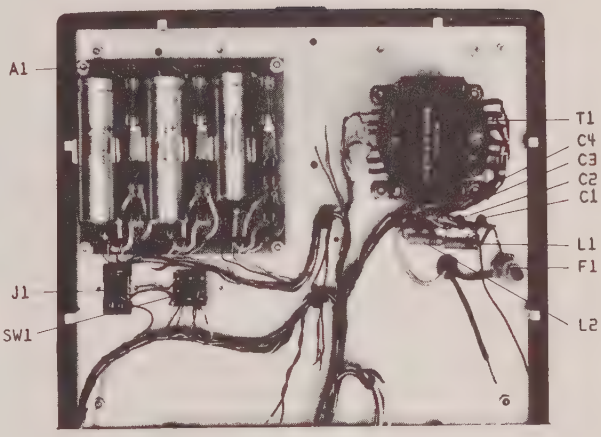


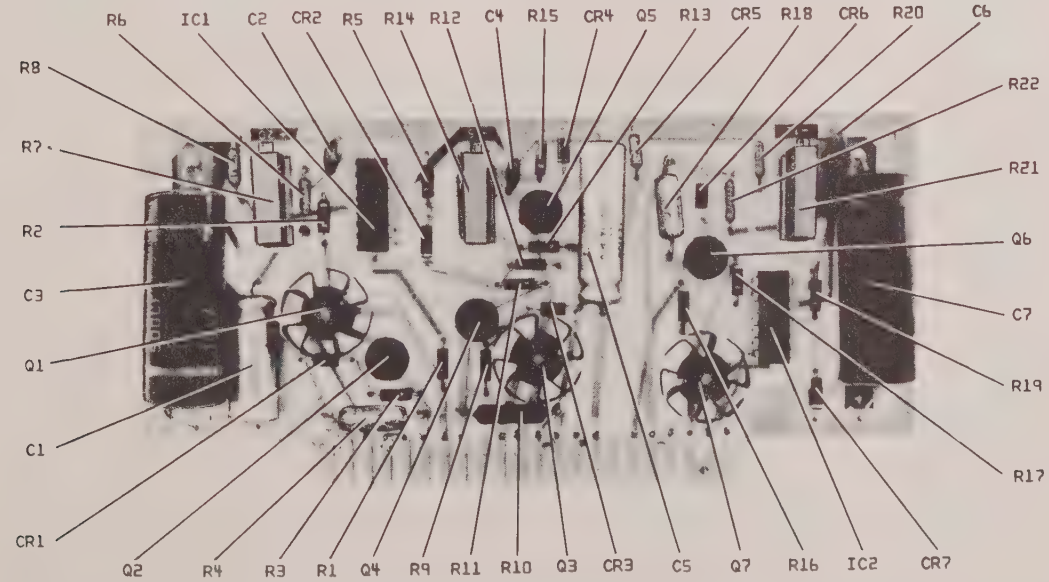
1 RESISTORS 1/4W 5% VALUES IN OHMS UNLESS OTHERWISE NOTED
2 CAPACITORS - VALUES IN µf UNLESS OTHERWISE NOTED
3 INDUCTORS VALUES IN µh UNLESS OTHERWISE NOTED
4 -- FACTORY SELECTED VALUE
5 ALL VOLTAGE READINGS ARE DC UNLESS OTHERWISE NOTED

Figure 6-17. Signal Generator Mixer (CH-A7)

6.3.18 Rear Panel, RP; Power-Supply Rectifiers RP-A1; and Power-Supply Regulators, CH-A19







6.3.18 POWER SUPPLY RECTIFIERS, RP-A1, POWER SUPPLY REGULATORS, CH-A19, REAR PANEL

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
RP	Rear Panel Assy	7000-0004	Cushman
	CAPACITORS		
C1	Cer, 0.01 MF ±20%, 1.4kV	1005-0051	Sprague
C2	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C3	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C4	Cer, 0.01 MF ±20%, 1.4kV	1005-0051	Sprague
	COILS		
L1	RF Choke, 100 μH ±10%, 600V	1585-0048	Miller
L2	RF Choke, 100 μH ±10%, 600V	1585-0048	Miller
	CONNECTORS		
P1	Moulded Plug, 3 Wire, 18 Gauge	3170-0001	Belden
J1	8 Pin Female	2535-0003	Cinch-Jones
	FUSES		
F1	3AG 1 Amp Slo-Blo	1955-0006	Littelfuse
	Fuse Clip	3705-0005	Keystone
	SWITCHES		
SW1	Slide, 3 P.D.T.	1850-0011	Switchcraft
	TRANSFORMERS		
T1	Transformer, Power	1575-0006	Cushman

6.3.18 POWER SUPPLY RECTIFIERS, RP-A1, POWER SUPPLY REGULATORS, CH-A19, REAR PANEL (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A19	Power Supply Regulator Board Assy	7000-0082	Cushman
	Printed Circuit Board, Bare	1780-0082C	Cushman
	CAPACITORS		
C1	Elect., 100 MF, 25V	1013-0003	Sprague
C2	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C3	Elect., 500 MF, 25V	1014-0002	Whale
C4	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C5	Elect., 250 MF, 12V	1013-0012	Sprague
C6	Cer, 0.002 MF ±20%, 600V	1005-0003	Erie
C7	Elect., 500 MF, 25V	1014-0002	Whale
	DIODES		
CR1	Si, 1N4002	1281-0023	ITT
CR2	Si, Zener, 6.8V, 1N957	1281-0007	Fairchild
CR3	Si, 1N4002	1281-0023	ITT
CR4	Si, Zener, 4.3V, 1N4731	1281-0025	Semcor
CR5	Si, Zener, 7.5V, ZD7.5A	1281-0026	Semcor
CR6	Si, 1N4002	1281-0023	ITT
CR7	Si, Zener, 6.8V, 1N957	1281-0007	Fairchild
	HEAT SINKS		
	Holder Radiator for 2N3053 (3)	1970-0001	Augat
	INTEGRATED CIRCUITS		
IC1	Op. Amp., 741C	2025-0022	Amelco
IC2	Op. Amp., 741C	2025-0022	Amelco
	PIN SPREADERS		
	Pin Spreader for 2N3053 (3)	3001-0006	Ross
	Pin Spreader for 2N3567 (4)	3001-0006	Ross
	RESISTORS		
R1	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R2	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R3	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R4	WW, 1Ω ±5%, 3W	1159-0901	Ohmite
R5	Comp, 1.8kΩ ±5%, 1/4W	1066-1825	Allen-Bradley

6.3.18 POWER SUPPLY RECTIFIERS, RP-A1, POWER SUPPLY REGULATORS, CH-A19, REAR PANEL

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
RP-A1	Power Supply Rectifier Board Assy	7000-0084	Cushman
	Printed Circuit Board, Bare	1780-0084	Cushman
	CAPACITORS		
C1	Elect., 2300 MF, 50V	1014-0004	Sprague
C2	Elect., 2300 MF, 50V	1014-0004	Sprague
C3	Elect., 4000 MF, 25V	1014-0005	Sprague
	DIODES		
CR1	Si, 1N4002	1281-0023	ITT
CR2	Si, 1N4002	1281-0023	ITT
CR3	Si, 1N4002	1281-0023	ITT
CR4	Si, 1N4002	1281-0023	ITT
CR5	Si, 1N4002	1281-0023	ITT
CR6	Si, 1N4002	1281-0023	ITT
CR7	Si, 1N4002	1281-0023	ITT
CR8	Si, 1N4002	1281-0023	ITT
CR9	1N5197	1281-0024	Semtech
CR10	1N5197	1281-0024	Semtech
CR11	1N5197	1281-0024	Semtech
CR12	1N5197	1281-0024	Semtech
	FUSES		
F1	1 Amp Slo-Blo Fuse	1955-0006	Buss
F2	1 Amp Slo-Blo Fuse	1955-0006	Buss
F3	1-1/2 Amp Fuse	1955-0007	Buss

6.3.18 POWER SUPPLY RECTIFIERS, RP-A1, POWER SUPPLY REGULATORS, CH-A19, REAR PANEL (Continued)

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
R6	Metal Film, 887Ω ±1%, 1/8W	1075-0022	Dale
R7	Pot., Cermet, 20T, 500Ω	1215-0002	Helitrim
R8	Metal Film, 2.21kΩ 1%, 1/8W	1075-0010	Dale
R9	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R10	WW, 0.5Ω ±3%, 3W	1159-0002	Ohmite
R11	Comp, 6.8kΩ ±5%, 1/4W	1066-6825	Allen-Bradley
R12	Comp, 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
R13	Comp, 10Ω ±5%, 1/4W	1066-1005	Allen-Bradley
R14	Pot., Cermet trim, 20T, 100Ω	1215-0001	Helitrim
R15	Comp, 270Ω ±5%, 1/4W	1066-2715	Allen-Bradley
R16	Comp, 470Ω ±5%, 1/4W	1066-4715	Allen-Bradley
R17	Comp, 1kΩ ±5%, 1/4W	1066-1025	Allen-Bradley
R18	WW, 1Ω ±3%, 3W	1159-0001	Ohmite
R19	Comp, 820Ω ±5%, 1/4W	1066-8215	Allen-Bradley
R20	Metal Film, 475Ω ±1%, 1/8W	1075-0023	Dale
R21	Pot., Cermet trim, 20T, 500Ω	1215-0002	Helitrim
R22	Metal Film, 475Ω ±1%, 1/8W	1075-0023	Dale
	TRANSISTORS		
Q1	Si, NPN, 2N3053	1272-0011	RCA
Q2	Si, NPN, 2N3567	1272-0014	Fairchild
Q3	Si, NPN, 2N3053	1272-0011	RCA
Q4	Si, NPN, 2N3567	1272-0014	Fairchild
Q5	Si, NPN, 2N3567	1272-0014	Fairchild
Q6	Si, NPN, 2N3053	1272-0011	RCA
Q7	Si, NPN, 2N3567	1272-0014	Fairchild

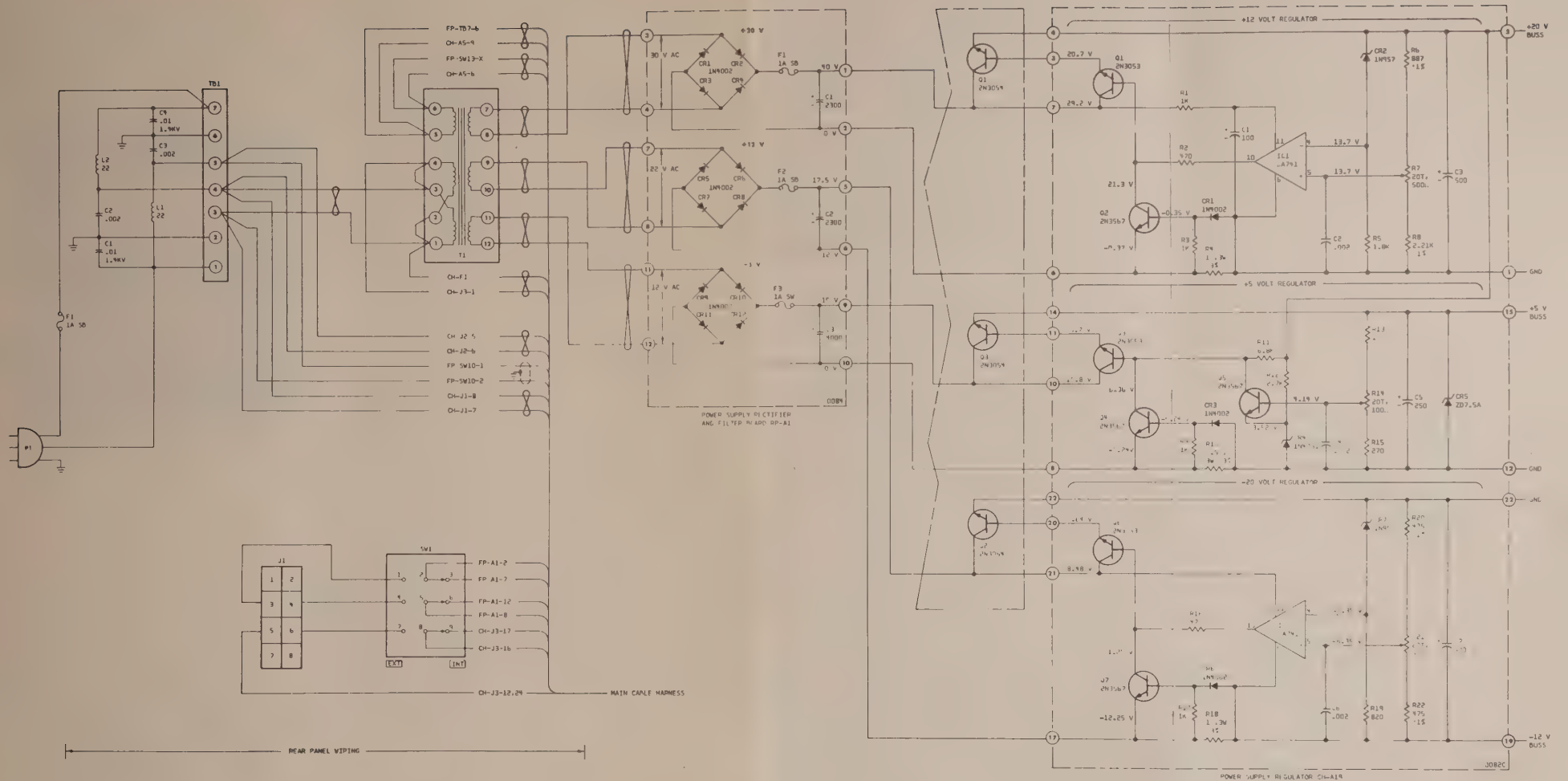
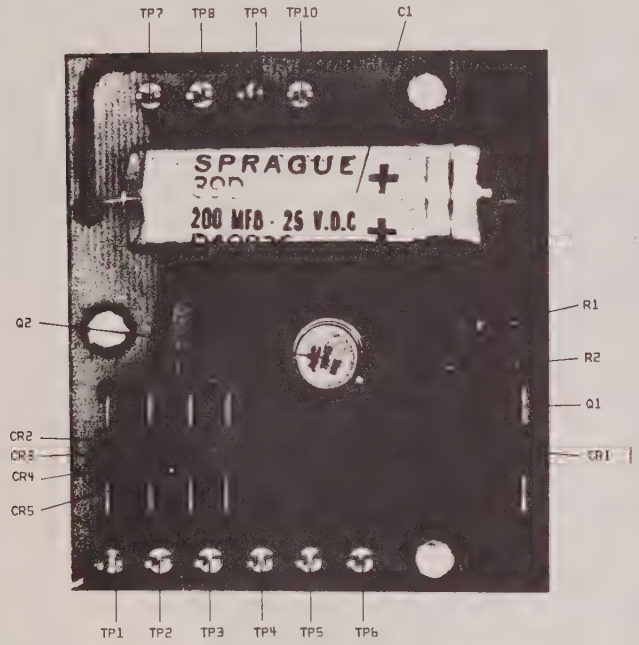


Figure 6-18. Power-Supply Rectifiers (RP-A1, 0084); Power-Supply Regulators (CH-A19, 0082); and Rear-Panel Wiring

6.3.19 Decimal Lights Circuit, CH-A5



6.3.19 DECIMAL-LIGHTS CIRCUIT, CH-A5

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
CH-A5	Decimal-Lights Circuit Board Assy	7000-0069	Cushman
	Printed Circuit Board, Bare	1780-0069	Cushman
	CAPACITORS		
C1	Elect., 200 MF, 25V	1013-0013	Sprague
	DIODES		
CR1	Si, 1N4002	1281-0023	ITT
CR2	Si, 1N3064	1281-0013	Sylvania
CR3	Si, 1N3064	1281-0013	Sylvania
CR4	Si, 1N3064	1281-0013	Sylvania
CR5	Si, 1N3064	1281-0013	Sylvania
	RESISTORS		
R1	Comp, 10kΩ ±5%, 1/4W	1066-1035	Allen-Bradley
R2	Comp, 1.2kΩ ±5%, 1/4W	1066-1225	Allen-Bradley
	TRANSISTORS		
Q1	Si, NPN, 2N3416	1271-0006	G.E.
Q2	Si, NPN, 2N3053	1272-0011	RCA

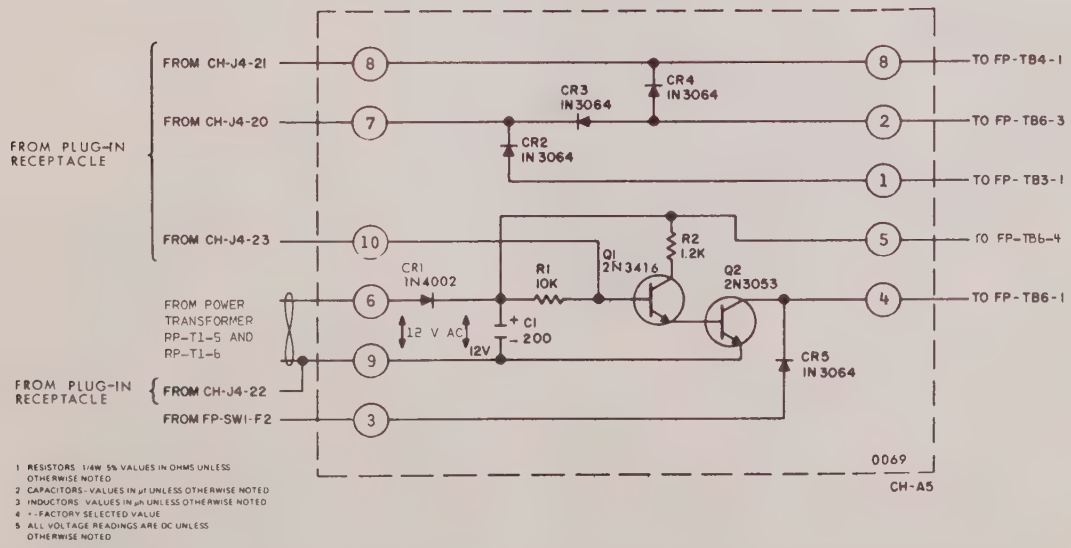
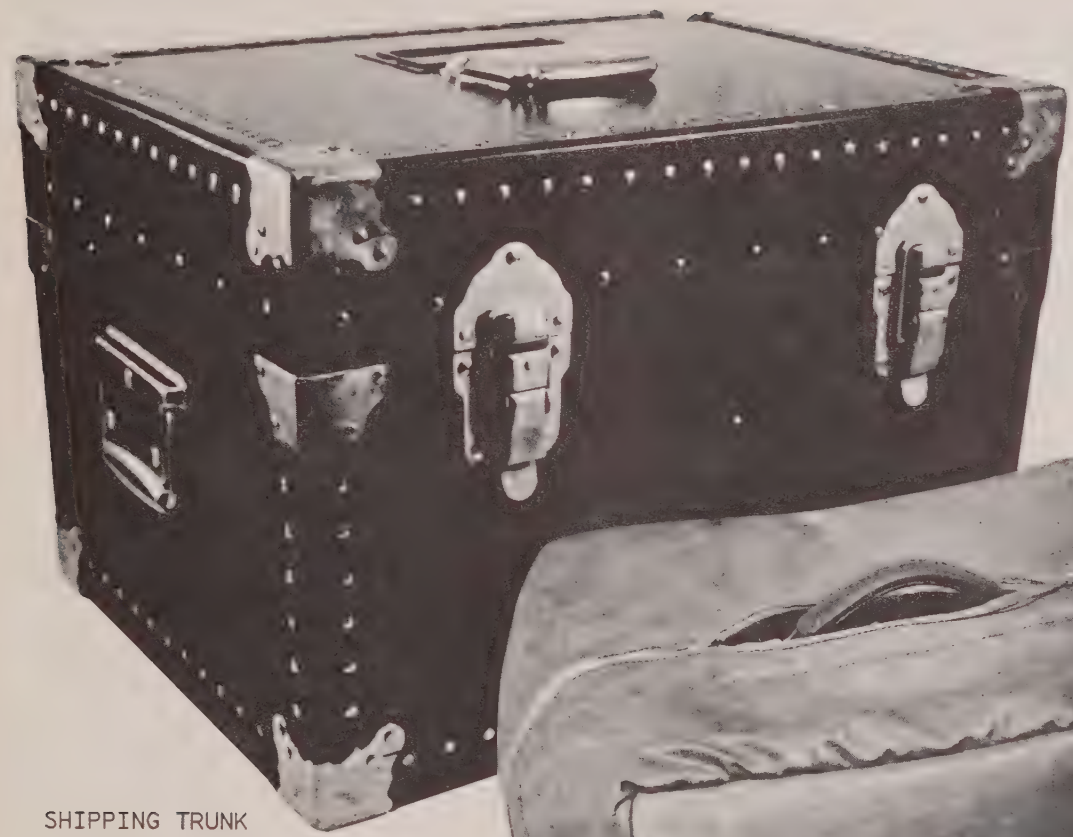


Figure 6-19. Decimal- and MHz/kHz/Hz Switching Circuits (CH-A5, 0069)

6.3.20 CE-3 Covers and Carrying Cases



SHIPPING TRUNK
(TYPICAL)

PROTECTIVE ZIPPER COVER
CARRYING CASE

6.3.20 CE-3 COVERS AND CARRYING CASES.

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	Bottom Cover Assy	7000-0008	Cushman
	Front Cover Assy	7000-0009	Cushman
	Cover, Left Side	2180-0032	Cushman
	Cover, Right Side	2180-0031	Cushman
	OPTIONAL ITEMS		
	Protective Zipper Cover (holds 1CE-3)	5287-0010	Cushman
	Shipping Trunk (holds 1 CE-3)	5287-0008	Cushman
	Carrying Case, Plug-Ins (holds 3 RF Plug-ins	5287-0009	Cushman
	Shipping Trunk, Plug-Ins (holds 3 RF Plug-ins plus 1 deviation plug-in)	5287-0011	Cushman

SECTION 7
PROVISIONS FOR USE OF THE MODEL 312

7.1 Introduction

To use the Model 312 Extender certain modifications must be performed to the CE-3 circuits described in this manual. Units (CE-3's) with serial numbers higher than 1295 are factory equipped with the provisions to permit use of the Model 312. These provisions consist of the addition of a printed circuit board called Relay Control Board, connections to the plug-in receptacle (J4-6 and J4-18), to a +12V unregulated supply point and to the function switch terminal carrying -12V (Figure 7-1), and a coaxial cable between J4-12/24 and J17-17/16 (Figure 7-2).

Coaxial relay K1 (not an addition) is now on the Relay Control Board which is mounted on stand-offs on the Decimal Lights Circuit Board CH-A5. (See Paragraph 6.3.12.) Also mounted on the relay control board are a resistor and a transistor.

To modify units with serial numbers lower than 1295 so that a Model 312 can be used, these units must be returned to the factory.

7.2 Operation

In instruments with serial numbers lower than 1295 the LO signal to the Broadband mixer or Preselector is supplied through J5 only when the function switch is in the FREQ.-DEV. MEASURE position; in CW or FM the LO signal is fed directly to the Signal Generator Mixer (CH-A7).

Since the purpose of the Model 312 is to extend the frequency range of the CE-3 to include frequency deviation and error measurement as well as signal generation in the frequency band of from 50 kHz to 20 MHz the LO signal must also be applied (through J5) when the CE-3 function switch is in either the CW or the FM position. The Relay Control Board provides this capability.

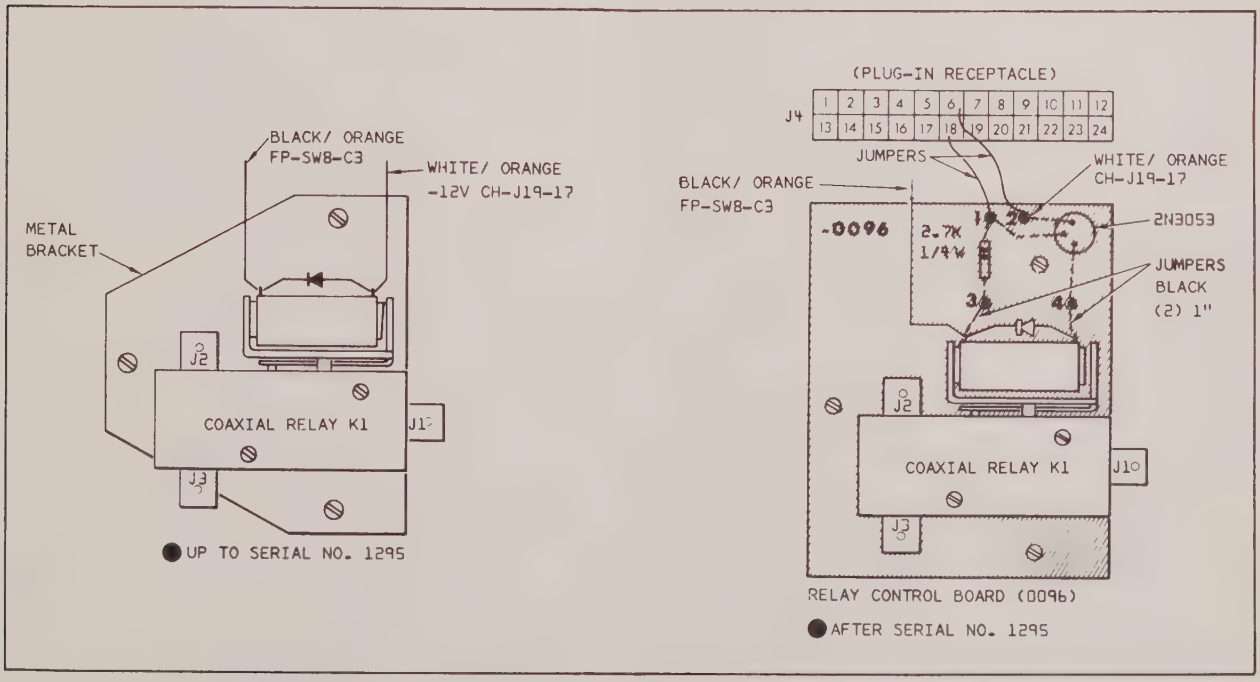


Figure 7-1. Relay Control Board (0096)

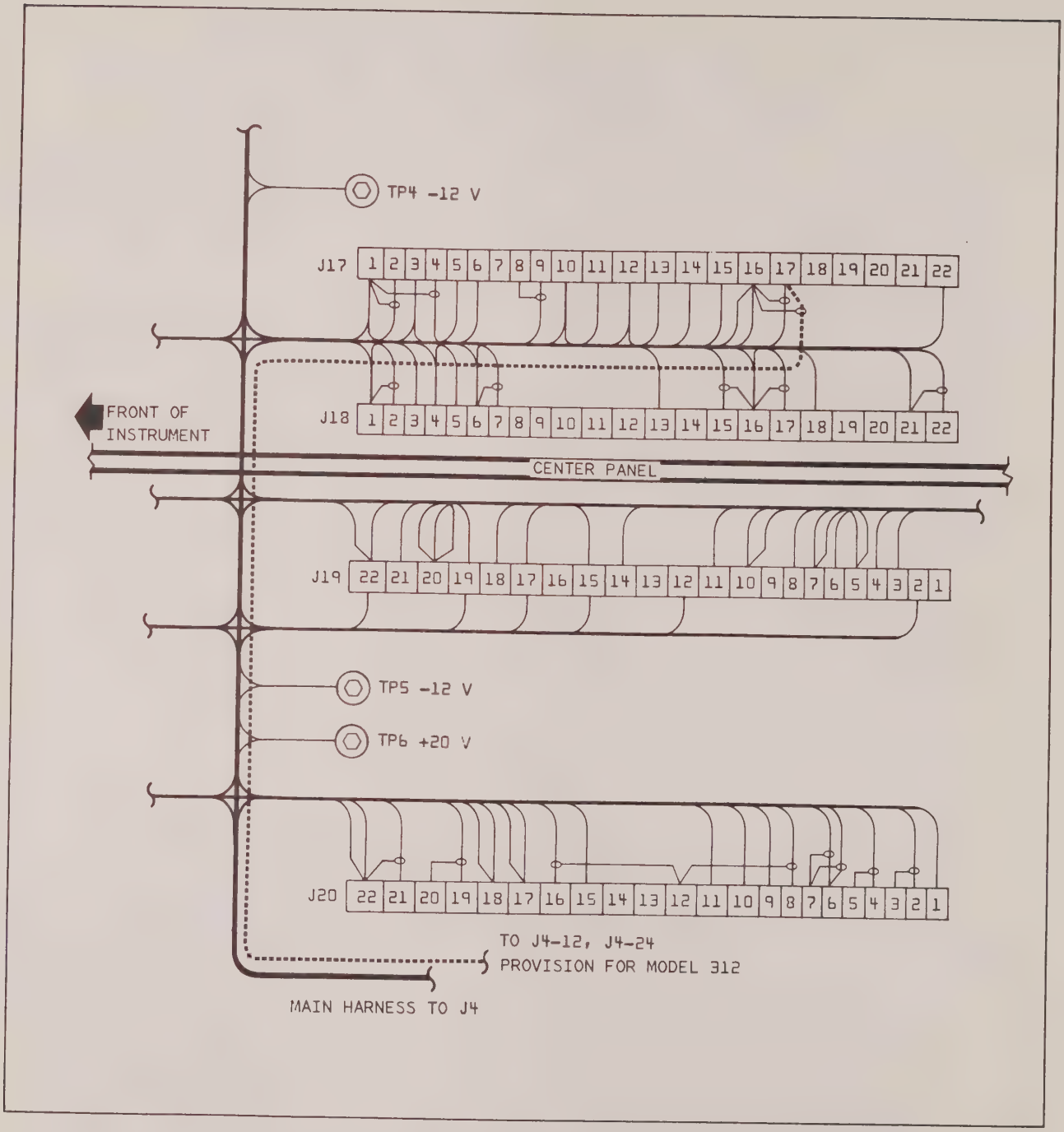


Figure 7-2. Cable Harness (Model 312 Provisions)

7.3 RELAY CONTROL BOARD ASSEMBLY

CKT. REF.	DESCRIPTION	C/E STOCK NO.	MFR.
	Relay Control Board Assembly	7000-0096	Cushman
	Printed Circuit Board, Bare	1780-0096	Cushman
	DIODE		
CR1	Si, 100V PIV, 1A, 1N4002	1281-0023	ITT
	RELAY		
K1	Coax., 50Ω, 250W, 28V	1313-0003	Dow-Key
	RESISTOR		
R1	Comp., 2.7kΩ ±5%, 1/4W	1066-2725	Allen-Bradley
	TRANSISTOR		
Q1	Si, NPN, 2N3053	1272-0011	RCA

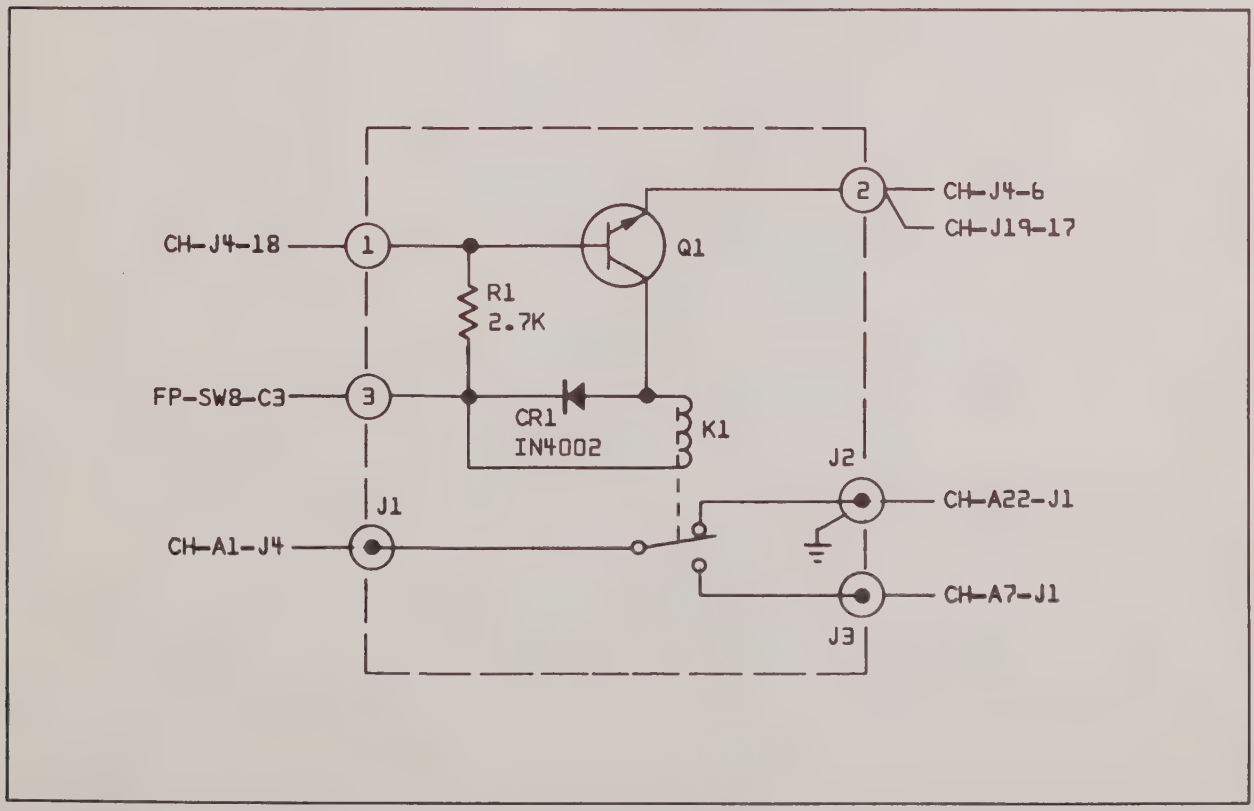


Figure 7-3. Relay Control Board, Schematic Diagram

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